普通高等教育“十三五”规划教材

Fundamentals of Manufacturing Technology Problems Set

英汉对照

机械制造技术基础习题集

任小中 任乃飞 ◎ 等编著

机械工业出版社
CHINA MACHINE PRESS

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任小中　任乃飞　薛进学　杨建军　编著

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本习题集条理清晰，重点突出，题型齐全，编写形式新颖，除附录外，共汇编了近800道习题，主要内容包括金属切削原理、机床与刀具、机械加工工艺的制订、机床夹具设计原理、机械加工质量分析与控制、机械装配技术基础和先进制造技术简介。每章习题均分为六部分：名词英汉对照、填空题、选择题、判断题、简答题、分析与计算题。学生可根据教学需要选做中文或英文习题。附录中备有自测练习和中、英文样卷，并附有参考答案，以供学生检验自己对所学知识的理解和掌握程度。

本习题集是以英汉双语的形式编著的与“机械制造技术基础”和“机械制造工艺学”课程配套的习题集，与机械工业出版社出版的《机械制造技术基础》（英汉双语对照）和《机械制造工艺学》（英汉双语对照）教材配套使用，可作为高等院校本、专科生同类课程双语教学的配套教材，或继续教育同类课程的辅助教材，也可供从事机械制造的有关技术人员作为参考资料。

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Preface

With the economic globalization and the increase of international communication activities, requirements of society for the talents in foreign language proficiency and international competitive power are getting higher and higher. To carry out bilingual teaching is an important measure to make the domestic higher education connect to international education.

Bilingual textbook is the basis of bilingual teaching. Appropriate bilingual textbook is the key to ensure high teaching quality. Two bilingual textbooks published by China Machine Press, i. e. *Fundamentals of Manufacturing Technology* written by Ren Xiaozhong, Ren Naifei and Wang Hongjun and *Machine Manufacturing Technology* written by Ren Xiaozhong and Zhou Jinmin, have provided high quality resources for the bilingual teaching of similar courses, and have got favourable comment from teachers and students. In order to fulfill the promise in the preface of these two books and to detect the understanding of the students on the contents of the textbook, combining with the published bilingual textbooks, we compiled this bilingual problems set written in both English and Chinese. This bilingual problems set written in both English and Chinese on the "Fundamentals of Manufacturing Technology" and the "Machine Manufacturing Technology". The purposes are to provide excellent teaching resource for the teaching of similar courses, especially for bilingual teaching and to improve teaching quality.

Taking "focused on 'learning activities', 'enhancing diathesis' as the goal" as guiding ideology, with an eye to enhancing students' comprehensive quality, this book integrated the teaching experiences accumulated by authors and inherited the essence of traditional teaching contents so as to encourage students to be active and enthusiastic in learning. For the convenience in use, the layout of this book is consistent with the bilingual textbook *Fundamentals of Manufacturing Technology* written by Ren Xiaozhong, Ren Naifei and Wang Hongjun, providing uniformity of teaching and learning as well as promoting interactive learning and exercises. This book can also be taken as the supplementary material of the bilingual textbook *Machine Manufacturing Technology* written by Ren Xiaozhong and Zhou Jinmin.

The book consists of seven chapters. Main contents include principles of metal cutting, machine tools and cutting tools, machining process planning, design principles of machine tool fixture, analysis and control of machining quality, fundamentals of machine assembly technalogy, and brief introduction to advanced manufacturing technology. The exercises in each chapter are divided into six parts: English-Chinese terms, filling in the blanks, making choice, true or false, short-answer questions, analysis and calculation. In the appendix, there are evaluation exercises and several test papers accompanied with answers, which are provided for students to test their understanding of what they have learned.

The book is written jointly by Prof. Ren Xiaozhong (Henan University of Science & Technolo-

gy), Prof. Ren Naifei (Jiangsu University), Xue Jinxue and Yang Jianjun (Henan University of Science & Technology). The specific division of the writing tasks is as follows: Ren Xiaozhong wrote Chapter 1, Chapter 4, Chapter 6, Chapter 7 and Appendix; Ren Naifei wrote Chapter 2, Chapter 5; Xue Jinxue wrote Section 3.1 to Section 3.3 of Chapter 3; Yang Jianjun wrote Section 3.4 to Section 3.6 of Chapter 3.

Ren Xiaozhong is in charge of overall compiling and editing the entire bilingual textbook.

The book has referenced some textbooks published at home and abroad. Hereon, we express a most cordially thank to the authors. At the same time, we also announce our sincerely acknowledgement to all who have provided their helps and kindness for the publication of the book.

Due to various limitations, there may be some improper contents or even mistakes in the first edition. We respectfully invite criticisms and corrections from all experts and readers for further improvement of the book so that the flaws and errors can be corrected in future versions.

Authors

前　　言

随着经济全球化和国际交流活动的日益频繁，社会对人才外语水平和国际竞争能力的要求越来越高。双语教学是我国高等教育与国际教育接轨的一项重要举措。

双语教材是开展双语教学的基础，合适的双语教材是保证双语教学质量的关键。由机械工业出版社出版，任小中、任乃飞、王红军编著的《机械制造技术基础》（英汉双语对照）和由任小中、周近民编著的《机械制造工艺学》（英汉双语对照），为同类课程双语教学提供了优质资源，深受任课教师和学生的好评。为了兑现在这两部教材“前言”中的承诺，更是为了便于检测学生对教材内容的理解和掌握程度，作者结合已出版的双语教材内容编写了这本英汉双语习题集。这部以中、英文形式编著的“机械制造技术基础”和“机械制造工艺学”方面的双语习题集，旨在为同类课程教学，尤其是双语教学提供优质的教学资源，保证教学质量。

本习题集以“学”为中心，以“提高素质”为目标，继承传统内容的精华，融入作者多年积累的教学经验，着眼于培养学生的综合素质，力求最大限度地调动学生学习的积极性和主动性。为方便使用，本习题集的编排顺序与由任小中、任乃飞、王红军编著的《机械制造技术基础》（英汉双语对照）教材体系一致，并相互配合，使教与学相统一、学与练相促进。本习题集也可作为由任小中、周近民编著的《机械制造工艺学》（英汉双语对照）教材的辅助教材。

本习题集共有七章，主要内容包括金属切削原理、机床与刀具、机械加工工艺的制订、机床夹具设计原理、机械加工质量分析与控制、机械装配技术基础、先进制造技术简介。每章习题均分为六个部分：名词英汉对照、填空题、选择题、判断题、简答题、分析与计算题。学生可根据教学需要选做中文或英文习题。附录中备有自测练习和样卷，并附有参考答案，以供学生检验自己对所学知识的理解和掌握程度。

本习题集由任小中教授（河南科技大学）、任乃飞教授（江苏大学）、薛进学和杨建军（河南科技大学）共同编著。具体编写分工为：任小中编写第 1 章、第 4 章、第 6 章、第 7 章和附录，任乃飞编写第 2 章和第 5 章，薛进学编写第 3 章的 3.1~3.3 节，杨建军编写第 3 章的 3.4 ~3.6 节。全书由任小中负责统稿。

本习题集参考了国内外出版的一些教材和习题集，谨此向有关作者表示诚挚的谢意！同时，向所有关心和帮助本书出版的人员表示感谢！

由于编者水平有限，书中难免有错漏和不当之处，敬请各位专家和广大读者批评指正。

作　者

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Chapter 1

Principles of Metal Cutting

第1章

金属切削原理

1.1 English-Chinese Terms 名词英汉对照

1. machining 机械加工
2. rake angle 前角
3. clearance angle 后角
4. leading cutting edge angle 主偏角
5. trailing cutting edge angle 副偏角
6. cutting edge inclination angle 刃倾角
7. primary motion 主运动
8. feed motion 进给运动
9. build-up edge 积屑瘤
10. tool life 刀具寿命
11. machining variables 切削用量

1.2 Filling in the blanks 填空题

1. In machining, the movement of ________________ is named as cutting motion. According to the function, the cutting motion can be divided into ________ and ________, where ________ consumes the largest power.

在加工中，________________运动称为切削运动。按其功用，切削运动可分为________和________。其中________运动消耗功率最大。

2. The three elements of machining variables mean ________, ________ and ________.

切削用量三要素是指________、________和________。

3. The assumptions for the reference system of static tool angle are ________ and ________.

刀具静止角度参考系的假定条件是________和________。

4. Common used section planes of cutting edge are ________, ________, ________ and ________, each of them and the reference plane and the cutting plane constitute the corresponding reference system.

常用的切削刃剖切平面有________、________、________和________，它们可分别与基面和切削平面组成相应的参考系。

5. The angle included between rake face and reference plane in orthogonal plane is called ________, and the angle included between the flank and cutting plane is called ________.

在正交平面内，前刀面与基面之间的夹角称为________，后刀面与切削平面之间的夹角称为________。

6. The condition to coincide the orthogonal plane and the normal plane is ________.

正交平面与法平面重合的条件是________________。

7. After the reference plane is determined, the rake face is determined by ________ and ________; the flank is determined by ________ and ________. The rake face and flank determines

a cutting edge, therefore, a cutting edge is determined by four angles, i. e. ________________, ________________, ________________ and ________________.

当基面确定后，前刀面由________和________两个角度确定；后刀面由________和________两个角度确定。前、后刀面确定了一条切削刃，所以一条切削刃由________、________、________、________四个角度确定。

8. Two types of reference systems to determine tool angles are ________ and ________.

用以确定刀具几何角度的两类参考坐标系为________和________。

9. Undeformed chip dimensions are ________, ________ and ________.

切削层参数有________、________和________。

10. The sequence to select machining variables is: the first is to select ________, then is ________, the last is to select ________.

切削用量选择的顺序是：先选________，再选________，最后选________。

11. Common physical phenomena in the metal cutting process are ________, ________, ________ and ________.

金属切削过程中常见的物理现象有________、________、________和________。

12. In the chip form, the chip can be classified as ribbon chip, ________, ________ and splintering chip.

从形态上看，切屑可以分为带状切屑、________、________和崩碎切屑四种类型。

13. The deformation zone Ⅱ occurs at ________, its deformation feature is ________.

第Ⅱ变形区发生在________，其变形特点是________。

14. Sources of cutting force are mainly from ________ and ________.

切削力的来源主要是________和________两方面。

15. With the increase of leading cutting edge angle, the back force F_p ________, the feed force F_f ________.

刀具主偏角增加，背向力 F_p ________，进给力 F_f ________。

16. The primary forms of the normal tool wear are ________, ________ and ________.

刀具正常磨损的主要形式有________、________和________。

17. The main causes of tool wear are ________, ________, ________ and oxidizing wear.

刀具磨损的原因主要有________、________、________和氧化磨损。

18. The functions of cutting fluids are ________, ________, ________ and ________. Common used types are ________, ________ and ________.

切削液的作用是________、________、________和________。常用种类有________、________和________。

19. The geometrical shapes of cutting tool mean ________, ________ and the shape of cutting edge.

刀具的几何形状指的是________、________和切削刃的形状。

20. In roughing, the main factor to restrict the feed is ________; in finishing, the main factor to restrict the feed is ________.

粗加工时，限制进给量的主要因素是________；精加工时，限制进给量的主要因素

是________。

21. The methods to measure cutting deformation are ________, ________.

衡量切削变形的方法有________、________两种。

22. When finish turning cast irons, (YG3、YT10、YG8)[㊀] should be selected; when rough turning steels, (YT5、YG6、YT30) should be selected.

精车铸铁时，应选用（YG3、YT10、YG8）；粗车钢时，应选用（YT5、YG6、YT30）。

23. When the feed rate increases, the cutting force (increases, decreases), and the cutting temperature (increases, decreases).

当进给量增加时，切削力（增加、减少），切削温度（增加、减少）。

24. (Water-based fluids, cutting oils) should be selected in finishing; the high carbon steels should be treated by (annealing, quenching[㊁]) in order to improve machinability.

精加工时应选择（水溶液，切削油）；为改善切削加工性，对高碳钢材料应进行（退火，淬火）处理。

1.3 Making choice 选择题

1. In longitudinal turning, the cutting force which does not consume power but has an effect on the machining accuracy is ____.

A. feed force　　B. back force

C. major cutting force　　D. resultant cutting force

纵车外圆时，不消耗功率但影响工件精度的切削分力是____。

A. 进给力　　B. 背向力　　C. 主切削力　　D. 总切削力

2. As for the influence of machining variables on cutting temperature, the influencing degree from large to small is ____.

A. $v_c \to a_p \to f$　　B. $v_c \to f \to a_p$　　C. $f \to a_p \to v_c$　　D. $a_p \to f \to v_c$

切削用量对切削温度的影响程度由大到小的顺序是____。

A. $v_c \to a_p \to f$　　B. $v_c \to f \to a_p$　　C. $f \to a_p \to v_c$　　D. $a_p \to f \to v_c$

3. One of the functions of the cutting edge inclination angle is to control the chip flowing direction. If the inclination angle is negative, the chip flows to ____.

A. machined surface　　B. surface to be machined

C. along the normal direction to the cutting edge　　D. uncertain

刃倾角的功用之一是控制切屑流向。若刃倾角为负，则切屑流向____。

A. 已加工表面　　B. 待加工表面

C. 沿切削刃的法线方向　　D. 不确定

4. The carbides often used to cut brittle materials belong to ____.

A. YT type (P)　　B. YG type (K)　　C. YW type (M)　　D. diamond

㊀ 从括号中勾选出正确的一项即可，后同。

㊁ 淬火有时翻译为“hardening”，本书统一使用“quenching”。

常用于切削脆性材料的硬质合金属于____。

A. YT 类（P 类） B. YG 类（K 类） C. YW 类（M 类） D. 金刚石

5. The element which has the largest effect on cutting force is ____.

A. cutting thickness B. cutting depth C. feed D. cutting speed

对切削力影响最大的因素是____。

A. 切削厚度 B. 切削深度 C. 进给量 D. 切削速度

6. In surface grinding, the grade and structure of grinding wheel should be ____.

A. soft and dense B. soft and open C. hard and dense D. hard and open

在磨削平面时，砂轮的硬度和组织应该是____。

A. 软、紧密 B. 软、疏松 C. 硬、紧密 D. 硬、疏松

7. The number of primary motion may be ____.

A. only one B. two C. three D. four

主运动的数量可能是____。

A. 只有 1 个 B. 2 个 C. 3 个 D. 4 个

8. The carbides used to cut both steels and cast irons belong to ____.

A. YT type（P） B. YG type（K） C. YW type（M） D. diamond

既可以用于切削钢材也可以用来切削铸铁的硬质合金属于____。

A. YT 类（P 类） B. YG 类（K 类） C. YW 类（M 类） D. 金刚石

9. The element which has the largest effect on cutting temperature is ____.

A. cutting thickness B. cutting depth C. feed D. cutting speed

对切削温度影响最大的因素是____。

A. 切削厚度 B. 切削深度 C. 进给量 D. 切削速度

10. In finish grinding, the grade and structure of grinding wheel should be ____.

A. soft and dense B. soft and open C. hard and dense D. hard and open

在精磨时，砂轮的硬度和组织应该是____。

A. 软、紧密 B. 软、疏松 C. 硬、紧密 D. 硬、疏松

11. Of the three components of cutting force, ____ consumes the largest power.

A. feed force F_x B. radial cutting force F_y C. main cutting force F_z D. uncertain

在车削的三个切削分力中，____消耗的功率最大。

A. 进给抗力 F_x B. 径向切削力 F_y C. 主切削力 F_z D. 不确定

12. In turning, the surface, which is on the cutting tool, facing to the machined surface is ____.

A. rake face B. flank C. minor flank D. reference plane

切削时刀具上与工件已加工表面相对的表面是指车刀的____。

A. 前面 B. 主后刀面 C. 副后刀面 D. 基面

13. The angle included between the major cutting edge and reference plane in cutting plane is ____.

A. γ_o B. α_o C. κ_r D. λ_s

在切削平面中测量的主切削刃与基面之间的夹角是 ____。

A. 前角 γ_o　B. 后角 α_o　C. 主偏角 κ_r　D. 刃倾角 λ_s

14. YT type carbides are mainly used to cut ____。

A. steels　B. cast irons　C. ceramics　D. diamonds

YT 类硬质合金刀具主要用于加工____。

A. 钢　B. 铸铁　C. 陶瓷　D. 金刚石

15. The plane which passes through a designated point on the cutting edge and is perpendicular to the direction of primary motion is called ____ .

A. cutting edge plane　B. feed plane　C. reference plane　D. orthogonal plane

通过切削刃选定点，垂直于主运动方向的平面称为____。

A. 切削平面　B. 进给平面　C. 基面　D. 主剖面

16. The angle included between the rake face and reference plane in orthogonal plane is ____.

A. rake angle　B. clearance angle

C. cutting edge angle　D. cutting edge inclination angle

在正交平面内度量的基面与前刀面的夹角为____。

A. 前角　B. 后角　C. 主偏角　D. 刃倾角

17. Cutting edge inclination angle is the angle included between major cutting edge and ____.

A. cutting edge plane　B. reference plane

C. major motion direction　D. feed direction

刃倾角是主切削刃与____之间的夹角。

A. 切削平面　B. 基面　C. 主运动方向　D. 进给方向

18. In turning, the working rake angle of the lathe cutter ____ the designated rake angle of the lathe cutter.

A. is larger than　B. equals

C. is smaller than　D. is at times larger or smaller than

车削加工时，车刀的工作前角____车刀标注前角。

A. 大于　B. 等于　C. 小于　D. 有时大于，有时小于

19. When using the carbides cutter for finish cutting the workpiece made of carbon steel, the cutting tool material should be ____.

A. YT30　B. YT5　C. YG3　D. YG8

用硬质合金刀具对碳素钢工件进行精加工时，应选择刀具材料的牌号为____。

A. YT30　B. YT5　C. YG3　D. YG8

1.4 True or false 判断题

1. The phenomena such as BUE, wear on the rake face etc. occurred in cutting are caused by the deformation produced in the deformation zone Ⅲ. (　　)

切削时出现的积屑瘤、前刀面磨损等现象，都是第Ⅲ变形区的变形所造成的。(　　)

2. The deformation produced in the deformation zone Ⅲ is the leading cause of machined sur-

face hardening and residual stress. ( )

第Ⅲ变形区的变形是造成已加工表面硬化和残余应力的主要原因。( )

3. Under the condition of forming cracked chip, the splintering chip may be occurred by decreasing the rake angle and cutting speed, and increasing the cutting thickness. ( )

在形成挤裂切屑的条件下，若减小刀具前角，降低切削速度，加大切削厚度，就可能得到崩碎切屑。( )

4. Under the condition of forming cracked chip, the ribbon chip may be occurred by increasing the rake angle and cutting speed, and decreasing the cutting thickness. ( )

在形成挤裂切屑的条件下，若加大刀具前角，提高切削速度，降小切削厚度，就可能得到带状切屑。( )

5. Major cutting force F_c is the main basis for calculating the machine tool power and designing the fixture and cutting tool. ( )

主切削力 F_c 是计算机床功率及设计夹具、刀具的主要依据。( )

6. Feed force F_f is the important basis for designing and checking the strength of machine tool's feed mechanism. ( )

进给抗力 F_f 是设计和校验机床进给机构强度的重要依据。( )

7. Cutting power is the power consumed mainly by primary motion and major cutting force. ( )

切削功率主要是主运动和主切削力所消耗的功率。( )

8. There are many factors influencing on the cutting force. Tool material, tool wear and cutting fluid are the uppermost factors. ( )

影响切削力的因素很多，其中最主要的是刀具材料、刀具磨损、切削液。( )

9. The magnitude of cutting temperature depends on not only the amount of heat generated in the heat source, but also the heat dissipation condition. ( )

切削温度的高低不仅取决于热源区产生热量的多少，而且还取决于散热条件的好坏。( )

10. In finish machining, the BUE is beneficial for the cutting process. ( )

在精加工时，积屑瘤对切削过程是有利的。( )

11. In machining variables, the feed has the least effect on the tool life. ( )

切削用量中进给量对刀具寿命的影响最小。( )

12. There is only one feed motion in machining process. ( )

在切削加工中，进给运动只能有一个。( )

13. Other parameters are constant, if the cutting edge angle decreases, the cutting layer thickness increases. ( )

其他参数不变，主偏角减少，切削层厚度增加。( )

14. Other parameters are constant, if the cutting depth increases, the cutting width increases. ( )

其他参数不变，切削深度增加，切削层宽度增加。( )

15. The angle included between the leading cutting edge and feed direction is called leading

cutting edge angle. (   )

主切削刃与进给运动方向间的夹角为主偏角 κ_r。(   )

16. In cylindrical turning, if the tool nose is higher than the center of workpiece, the practical rake angle increases. (   )

车削外圆时，若刀尖高于工件中心，则实际前角增大。(   )

17. When cutting cast irons and other brittle materials, the K series (YG type) carbides should be selected. (   )

切削铸铁类等脆性材料时，应选择 K 类（YG 类）硬质合金。(   )

18. In rough machining, the carbides with lower cobalt content should be selected. (   )

粗加工时，应选择含钴量较低的硬质合金。(   )

19. Of the three cutting variables, the feed has the largest influence on the surface roughness. (   )

切削用量三要素中，进给量对表面粗糙度的影响最大。(   )

20. The cutters made of diamond can be used to cut ferrous metals like iron and steels. (   )

用金刚石制造的刀具可以切削像钢铁之类的黑色金属。(   )

21. Of the three cutting variables, the cutting depth has the largest influence on the tool life. (   )

切削用量三要素中，切削深度对刀具寿命影响最大。(   )

22. The cutters made of high speed steel can be used to cut steel at higher speed than that of carbide cutters. (   )

高速钢刀具加工钢的切削速度可以比硬质合金刀具的还要高。(   )

23. "−" γ_o should be selected in finish turning. (   )

在精车时应选择负前角。(   )

24. The larger the tool life, the higher the cutting speed the cutter permits. (   )

刀具寿命越长，其允许的切削速度越高。(   )

1.5 Short-answer questions 简答题

1. How to distinguish primary motion from feed motion?

如何区别主运动和进给运动？

2. What are the reference planes in the orthogonal plane reference system?

在正交平面参考系中都有哪些参考平面？

3. What properties should the cutting tool materials have?

刀具材料应具备哪些性能?

4. What are the common used cutting tool materials?
常用的刀具材料有哪些?

5. What are the common used carbides? How about their usages? How to select them?
常用的硬质合金刀具材料有哪些? 它们各自的用途如何? 应如何选择?

6. How is the influence of build-up edge on cutting process? List the measures to prevent it.
积屑瘤对切削过程有何影响? 列出防治积屑瘤产生的措施。

7. What are the factors which affect the cutting force?
影响切削力的因素是什么?

8. What are the factors which affect the cutting temperature?
影响切削温度的因素有哪些?

9. What is the tool wear limit? What does the tool life mean?
何谓刀具磨钝限度? 刀具寿命指的是什么?

10. What are the factors affecting the tool life?
影响刀具寿命的因素有哪些?

11. What functions does the cutting fluid have? How many kinds of cutting fluids are there?
切削液都有哪些功用? 切削液有哪些种类?

12. What do the undeformed chip dimensions mean? What are the relations of cutting depth ,

feed to undeformed chip dimensions respectively?

切屑层参数指的是什么？与切削深度和进给量有什么关系？

13. What is the tool life with maximum productivity? What is the tool life with the minimum cost?

何谓最大生产率刀具寿命和最低成本刀具寿命？

14. What factors should be considered when you determine the tool life?

确定刀具寿命时应当考虑哪些因素？

15. Indicate the primary motion and feed motion respectively in cylindrical turning, milling, drilling, shaping, planning and grinding.

分别指出外圆车削、铣削、钻削、牛头刨削、龙门刨削和磨削加工的主运动和进给运动。

16. What are the indexes and methods to measure the "machinability" of workpiece materials ? Indicate the ways to improve machinability.

衡量工件材料切削加工性的评价指标和方法有哪些？试述改善工件材料的切削加工性的途径。

1.6 Analysis and calculation 分析与计算题

1. How do you choose the machining variables? In choosing machining variables, the first is to choose a_p, then is the f, and the last is to choose v_c, why?

如何选择切削用量？在选择切削用量时，为什么要先选 a_p，再选 f，最后选 v_c？

2. Indicate the functions of γ_o, α_o, κ_r, κ_r and λ_s. How to select them?

指出刀具前角 γ_o、后角 α_o、主偏角 κ_r、副偏角 κ_r'和刃倾角 λ_s 的功用。如何选择这些角度？

3. Take the cutter (see Fig. 1-1) for example, and indicate the γ_o, α_o, κ_r, κ'_r and λ_s on the

drawing.

在图 1-1 所示的刀具图上标出 γ_o、α_o、κ_r、κ_r' 和 λ_s。

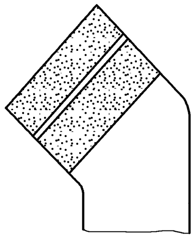


Fig. 1-1 Lathe cutter 车刀

4. Fig. 1-2 shows a sketch of turning hole an a lathe. Try to label cutter angles on the drawing: γ_o, α_o, κ_r, κ_r' and λ_s.

图 1-2 所示为在车床上镗孔示意图。试在图上标出镗刀的 γ_o、α_o、κ_r、κ_r'和 λ_s。

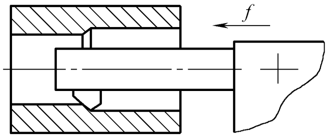


Fig. 1-2 Boring tool 镗刀

5. Fig. 1-3 shows a sketch of parting-off tools. Try to inclicate the angles γ_o, α_o, κ_r', κ_r' in reference system with orthogonal plane. (Attention: the primary motion direction v_c, feed motion direction v_f, reference plane P_r and projection plane P_s have to be indicated.)

试画出图 1-3 所示切断刀在正交平面参考系的标注角度 γ_o、α_o、κ_r、κ_r'(要求标出假定主运动方向 v_c、假定进给运动方向 v_f、基面 P_r 和切削平面 P_s)。

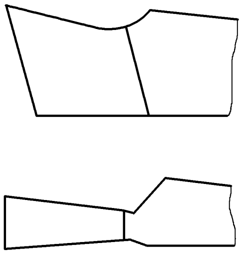


Fig. 1-3 Parting-off tool 切断刀

6. Fig. 1-4 shows a sketch of facing on a lathe. Try to indicate the cutting depth a_p, feed f,

cutting thickness h_D, cutting width b_D. If $a_p=5$mm, $f=0.3$mm, $\kappa_r=45°$, try to calculate the cutting area A_D.

图 1-4 所示的车端面，试标出背吃刀量 a_p、进给量 f、切削厚度 h_D、切削宽度 b_D。若 $a_p=5$mm，$f=0.3$mm，$\kappa_r=45°$，试求切削面积 A_D。

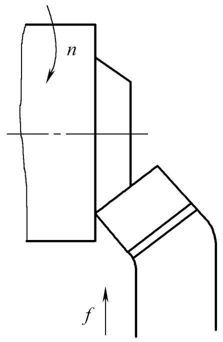


Fig. 1-4 Facing 车端面

7. Given that the cutting speed $v=100$m/min, a shaft made of 45 steel is cut by means of a lathe cutter made of carbide alloy. If the cutting area is kept unchanged, when $a_p=3$mm, $f=0.3$mm/r and $a_p=1.5$mm, $f=0.6$mm/r are used respectively, try to find the main cutting force F_c and cutting power P_m respectively.

用硬质合金车刀以 $v=100$m/min 的切削速度车削一根材料为 45 钢的轴。假设切削面积保持不变，当分别选用 $a_p=3$mm, $f=0.3$mm/r 和 $a_p=1.5$mm, $f=0.6$mm/r 的切削用量切削时，试分别求出各自的主切削力 F_c 和切削功率 P_m。

8. When turning a shaft made of gray cast iron by means of Q lathe cutter made of carbide alloy YG8, $a_p=3$mm, $f=0.3$mm/r are chosen. Given that $\kappa_r=60°$, try to find the cutting speed v if the tool life is 60min.

当用硬质合金 YG8 车刀车削一根材料为灰铸铁的轴时，选用 $a_p=3$mm, $f=0.3$mm/r。已知刀具的主偏角为 $\kappa_r=60°$，试求刀具寿命为 60min 时的切削速度 v。

9. What kind of tool material dose the W18Cr4V, YT15, YG8 belong to respectively? What materials do they suit for cutting?

W18Cr4V、YT15、YG8 三种刀具材料各属于哪类刀具材料？适合加工何种工件材料？

10. It is found that the cutting load of machine tool is over heavy in turning operation. What is the best way to reduce the cutting load without decreasing machining efficiency?

若车削时发现机床负载过重，在不影响加工效率的前提下，用什么方法来降低机床负载最好？

11. Try to design several methods of delivering cutting fluid to the tool-workpiece interface and discuss the advantages and shortcomings of your design.

试设计出几种向刀具-工件接触区输送切削液的方法，并探讨所设计方案的优缺点。

12. Describe in detail your thoughts regarding the technical and economic factors involved in tool material selection.

详细阐述你在刀具材料选择方面有关技术和经济因素的想法。

Chapter 2

Machine Tools and Cutting Tools

第2章

机床与刀具

2.1 English-Chinese Terms 名词英汉对照

1. machine tool 机床
2. simple forming motion 简单运动
3. compound forming motion 复合运动
4. transmission chain 传动链
5. external-connection transmission chain 外联系传动链
6. internal-connection transmission chain 内联系传动链
7. transmission system diagram 传动系统图
8. grinding machine 磨床
9. grade of grinding wheel 砂轮硬度

2.2 Filling in the blanks 填空题

1. The motions of machine tools are divided into ____________ and ____________. The surface forming motions can be divided into ____________ and ____________.

机床的运动分为____________和____________。其中表面成形运动又分为____________和____________。

2. The transmission chains in the lathe CA6140 are ____________, ____________ and ____________. The transmission chain of the feed motion can be divided into ____________, ____________ and ____________.

CA6140 型车床传动系统具有的传动链是____________、____________和____________。其中进给运动传动链分为____________、____________和____________。

3. There are four types of surface forming methods, i. e. tracing, ____________, tangent tracing, ____________.

有四种表面成形方法，即轨迹法、____________、相切轨迹法和____________.

4. Based on the degree of specialization, machine tools are classified as ____________, ____________, and ____________.

机床按专业化程度分为____________、____________和____________。

5. The lathe CA6140 can be used for cutting 4 kinds of standard threads, that is, metric thread, ____________, ____________ and diametral pitch thread.

CA6140 型车床可车削米制螺纹、____________、____________、径节螺纹四种标准螺纹。

6. The most basic motion of machine tools is ____________.

机床最基本的运动是________________________。

7. The functions of the friction clutch of a lathe are ____________ and ____________.

车床摩擦离合器的作用是____________和____________。

8. The parts at two ends of the primary transmission chain in horizontal lathe are

____________ and ____________ .

卧式车床中主传动链的两端件是____________和____________。

9. Grinding methods of cylindrical grinding machines are ____________ and ____________; grinding methods of centerless grinding machines are ____________ and ____________ .

外圆磨床的磨削方法有____________和____________；无心磨床的磨削方法有____________和____________。

10. The transmission mechanisms in the headstock of the lathe CA6140 include ____________ and ____________ .

CA6140 型车床主轴箱的传动机构包括____________和____________两部分。

11. When machining helical cylindrical gears in a gear hobbing machine, the machine should be of 4 kinds of motions: ____________, ____________, ____________ and ____________ .

在滚齿机上加工斜齿圆柱齿轮时，滚齿机应具有的运动是____________、____________、____________、____________。

12. The characteristics of grinding wheel are ____________, ____________, ____________, ____________ and ____________ .

砂轮的特性有____________、____________、____________、____________和____________。

13. Machine tool's model is composed of ____________ and ____________, and arranged in light of certain law. The symbol M stands for ____________ .

机床型号由____________与____________按一定规律排列组成，其中符号 M 代表____________。

14. A, (soft, hard) grinding wheel should be selected in rough grinding, and a (dense, open) grinding wheel should be selected in finish grinding

粗磨时，应选择（软、硬）砂轮，精磨时应选择（紧密、疏松）组织砂轮。

15. The basic parameters of machine tool include ____________, ____________, ____________ and ____________ .

机床的基本参数包括____________、____________、____________和____________。

2.3 Making choice (Individual, multiple choice) 选择题（单项、多项选择）

1. According to the degree of specialization, the lathe CA6140 belongs to ____.

A. specialized machine tool　　B. general purpose machine tool

C. special purpose machine tool　　D. ordinary machine tool

按照机床的通用程度，CA6140 型车床属于____。

A. 专门化机床　B. 通用机床　C. 专用机床　D 普通机床

2. The primary motion of a cylindrical grinding machine is ____.

A. translational motion of grinding wheel　　B. rotation of workpiece

C. rotation of grinding wheel　　D. translational motion of workpiece

外圆磨床中，主运动是____。

A. 砂轮的平动　B. 工件的转动　C. 砂轮的转动　D. 工件的平动

3. ____ should be selected in mass production.

A. A general purpose machine tool　B. A special purpose machine tool

C. A modular machine tool　D. A specialized machine tool

在大量生产时，应该选择____。

A. 通用机床　B. 专用机床　C. 组合机床　D. 专门化机床

4. The machine tools as below which are mainly used for machining hole are ____ .

A. drilling machine　B. milling machine　C. broaching machine　D. boring machine

下列各种机床中，主要用来加工内孔的机床有____。

A. 钻床　B. 铣床　C. 拉床　D. 镗床

5. Hole can be grinded on ____.

A. a high precision grinding machine　B. a general cylindrical grinding machine

C. a surface grinding machine　D. a universal cylindrical grinding machine

内孔磨削可以在____上进行。

A. 高精密磨床　B. 普通外圆磨床　C. 平面磨床　D. 万能外圆磨床

6. The machine tool whose operation principle is the same as the slotting machine is ____.

A. boring machine　B. milling machine　C. grinding machine　D. shaping machine

同插床工作原理相同的是　　　　　　　　　　　。

A. 镗床　B. 铣床　C. 磨床　D. 刨床

7. Compared with down milling, one of the advantages of up milling is ____.

A. simple in operation　B. high machining accuracy

C. good dispersion condition　D. stable movement of the worktable

逆铣与顺铣相比较，其优点之一是____。

A. 操作简单　B. 加工精度高

C. 散热条件好　D. 工作台运动稳定

8. When machining several holes on a large and medium sized workpiece, ____ should be selected.

A. a bench-type drilling machine　B. a an u pright drilling machine

C. a radial drilling machine　D. a boring machine

加工大中型工件的多个孔时，应选用的机床是____。

A. 台式钻床　B. 立式钻床　C. 摇臂钻床　D. 镗床

9. The machining method in gear hobbing belongs to ____.

A. tracing　B. generating　C. tangent tracing　D. forming

滚齿时齿廓的成形方法是____。

A. 轨迹法　B. 展成法　C. 相切法　D. 成形法

10. In hobbing the gear with z teeth, each time the hob with k threads turns a circle, the workpiece turns ____ circles correspondingly.

A. z　B. k　C. z/k　D. k/z

滚切齿数为 z 的齿轮时，头数为 k 的滚刀每转过一转，工件应相应地转过____转。
A. z B. k C. z/k D. k/z

11. In surface grinding, the grade and structure of the grinding wheel should be ____.
A. soft and dense B. soft and open C. hard and dense D. hard and open
平面磨削时，砂轮的硬度和组织应____。
A. 软、紧密 B. 软、疏松 C. 硬、紧密 D. 硬、疏松

12. The gear machining method which is of highest machining accuracy is ____.
A. gear milling B. gear shaping C. gear hobbing D. gear grinding
加工精度最高的齿轮加工方法是____。
A. 铣齿 B. 插齿 C. 滚齿 D. 磨齿

13. There are ____ transmission chains in the gear hobbing machine Y3150E.
A. 2 B. 3 C. 4 D. 5
Y3150E 滚齿机的传动链有____条。
A. 2 B. 3 C. 4 D. 5

14. In finish grinding, the grade and structure of the grinding wheel should be ____.
A. soft and dense B. soft and open C. hard and dense D. hard and open
精磨时，砂轮的硬度和组织应____。
A. 软、紧密 B. 软、疏松 C. 硬、紧密 D. 硬、疏松

15. The gear cutting method which belongs to forming method is ____。
A. gear milling B. gear shaping C. gear shaving D. gear honing
在下列齿轮加工方法中，属于成形法的是____。
A. 铣齿 B. 插齿 C. 剃齿 D. 珩齿

16. There are ____ transmission chains in the lathe CA6140.
A. 2 B. 3 C. 4 D. 5
CA6140 型车床的传动链有____条。
A. 2 B. 3 C. 4 D. 5

17. The first letter “C” in the machine tool model shows that the machine is a ____.
A. slotting machine B. gear cutting machine
C. lathe D. threading machine
机床型号的首位字母“C”表示该机床是____。
A. 插床 B. 齿轮加工机床
C. 车床 D. 螺纹加工机床

18. The first letter “L” in the machine tool model shows that the machine is a ____.
A. threading machine B. milling machine
C. broaching machine D. grinding machine
机床型号的首位字母“L”表示该机床是____。
A. 螺纹加工机床 B. 铣床 C. 拉床 D. 磨床

2.4 True or false 判断题

1. The grade of a grinding wheel mainly depends on the hardness of abrasive. ( )
砂轮的硬度主要取决于磨料的硬度。( )

2. The larger the grain number, the finer the grain size. ( )
磨粒号越大，磨粒越小。( )

3. All lathes are provided with lead screw. ( )
所有车床都具有丝杠。( )

4. "40" of "CA6140" means the Max. swing diameter on the bed is 400mm. ( )
CA6140 中的"40"表示床身最大回转直径为 400 mm。( )

5. When the machine tool is used to machine a specific surface, at least there is a primary motion and feed motion. ( )
机床加工某一具体表面时，至少有一个主运动和一个进给运动。( )

6. The modular machine tool composed of most general purpose units and a few of special purpose units is a special purpose machine tool with high efficiency. ( )
组合机床是由多数通用部件和少数专用部件组成的高效专用机床。( )

7. The horizontal boring machine can be used only for boring holes. ( )
卧式镗床只能用于镗孔加工. ( )

8. The universal cylindrical grinding machine M1432A can be used only for machining cylindrical surface, and can't be used for machining holes. ( )
M1432A 型万能外圆磨床只能加工外圆柱面，不能加工内孔。( )

9. The gear hobbing machine can be used for machining both external and internal straight cylindrical gears. ( )
滚齿机能够进行各种内、外直齿圆柱齿轮的加工。( )

10. The primary motion of double column planning machines is the reciprocating linear motion of the planer tool. ( )
龙门刨床的主运动是刨刀的往复直线运动。( )

2.5 Short-answer questions 简答题

1. How do you classify the machine tools based on the degree of specialization?
如何根据机床的专门化程度对机床进行分类？

2. What are the methods to produce the generating lines of surface?
形成表面发生线的方法有哪些？

3. Give the examples to indicate what the simple forming motion is, and what the compound forming motion is.
何谓简单运动？何谓复合运动？试分别举例说明。

4. What are the essential differences between the external-connection transmission chain and the internal-connection transmission chain?
外联系传动链和内联系传动链的本质区别是什么？

5. Describe the types of machining operations that can be performed on a lathe.
试描述能在车床上进行的工艺内容类型。

6. What are the functions of the transmission chain of feed motion?
进给运动传动链的作用有哪些？

7. What kinds of standard threads can be cut by the lathe CA6140?
用 CA6140 型车床可以切削哪几种标准螺纹？

8. What are the function of u_j and u_b?
$u_{基}$ 和 $u_{倍}$ 的作用是什么？

9. What are the main functions of a headstock?
主轴箱的主要作用有哪些？

10. What characteristics does the spindle of the lathe CA6140 have?
CA6140 型车床的主轴有哪些特征?

11. Why the pulley of the lathe CA6140 is named as unloaded pulley?
为什么 CA6140 型车床的带轮称为卸荷带轮?

12. What are the functions of a bidirectional friction clutch?
双向摩擦离合器的作用是什么?

13. Why the half nut mechanism is used in the lathe CA6140?
为什么 CA6140 型车床中要使用开合螺母?

14. What are the functions of interlock mechanisms and safety clutch es in the lathe CA6140? Analyze their operation principle.
CA6140 型车床中互锁机构和安全离合器的作用是什么?试分析它们的工作原理。

15. What is grinding? What are the characteristics of grinding process?
什么是磨削?磨削工艺的特征有哪些?

16. What are the characteristics of a grinding wheel? What does the grade mean? How to select the grade of grinding wheel?
砂轮都有哪些特性?砂轮硬度指的是什么?如何选择砂轮硬度?

17. What factors should be considered when you choose a grinding wheel?
选择砂轮时应考虑哪些因素？

18. List the types of grinding machines, and name their main functions.
列出磨床的类型，说明它们各自的主要作用。

19. How many methods are there in cutting gears? Which is the most widely used?
加工齿轮的方法有哪些？哪一种用途最广？

20. Why is the hob axis tilted with respect to the axis of the gear blank? What factors does the tilt angle relate to?
为什么滚刀要相对于齿轮的轴线倾斜一个角度？倾斜角度的大小与哪些因素有关？

21. What is up milling? What is down milling? Describe the relative characteristics of up milling and down milling.
何谓逆铣？何谓顺铣？试描述它们各自的特点。

22. Describe the different types of cutters used in milling operations, and give an application of each.
试述铣削加工中所使用的铣刀类型，并说出每种铣刀的用途。

23. How many methods can be used to machine a hole? List the machine tools and cutters used in making holes.
用于加工孔的方法有多少种？列出所有用于孔加工的机床和刀具。

24. What kinds of lathe cutters are often used on the lathe? Illustrate their functions respectively.
在车床上常用的车刀有哪几种类型？举例说明各自的功用。

2. 6 Analysis and calculation 分析与计算题

1. According to the transmission system shown in Fig. 2-1 a and b:

(1) To write out the expression formula of the transmission route of primary motion.

(2) To find the revolution levels of spindle.

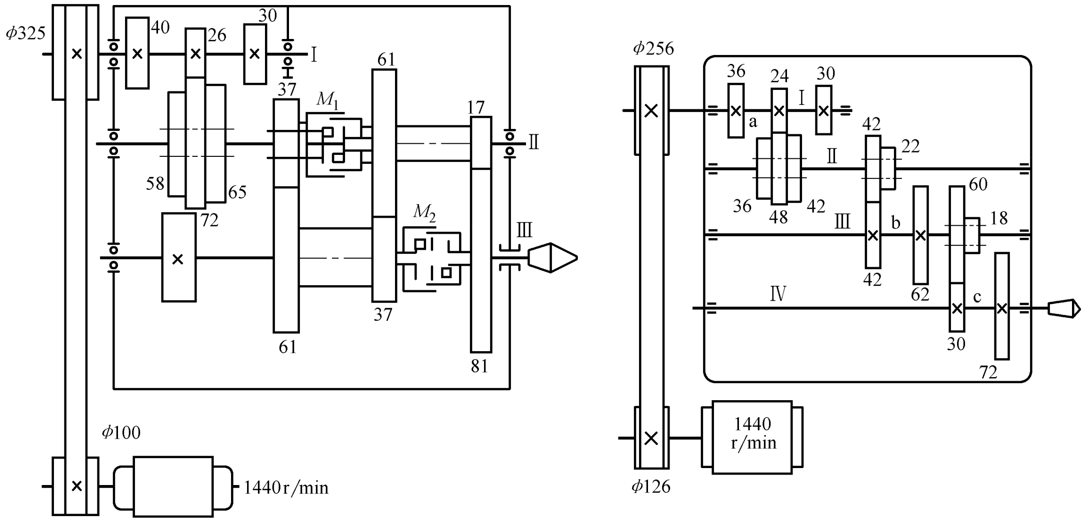
(3) To calculate the highest and lowest RPMs of spindle.

根据图 2-1a 和 b 所示的传动系统:

(1) 写出主运动传动路线的表达式。

(2) 求出主轴的转速级数。

(3) 计算最高和最低转速。



a) b)

Fig. 2-1 Transmission system of a machine tool 机床传动系统图

2. According to the transmission system diagram of the lathe CA6140 (shown in Fig. 2-2):

(1) To write out the expression formula of the transmission route of primary motion; To find the revolution levels of the spindle; To calculate the highest and lowest RPM of the spindle.

(2) To write out the transmission route expression in cutting metric system thread.

根据图 2-2 所示的 CA6140 型车床传动系统图：

(1) 写出主运动传动路线的表达式；求出主轴的转速级数；计算最高和最低转速。

(2) 写出加工米制螺纹的传动路线表达式。

3. The following threads are to be cut on the lathe CA6140:

(1) Metric thread: $P=3$mm, $n=2$.

(2) Inch thread: $a=4$teeth/in.

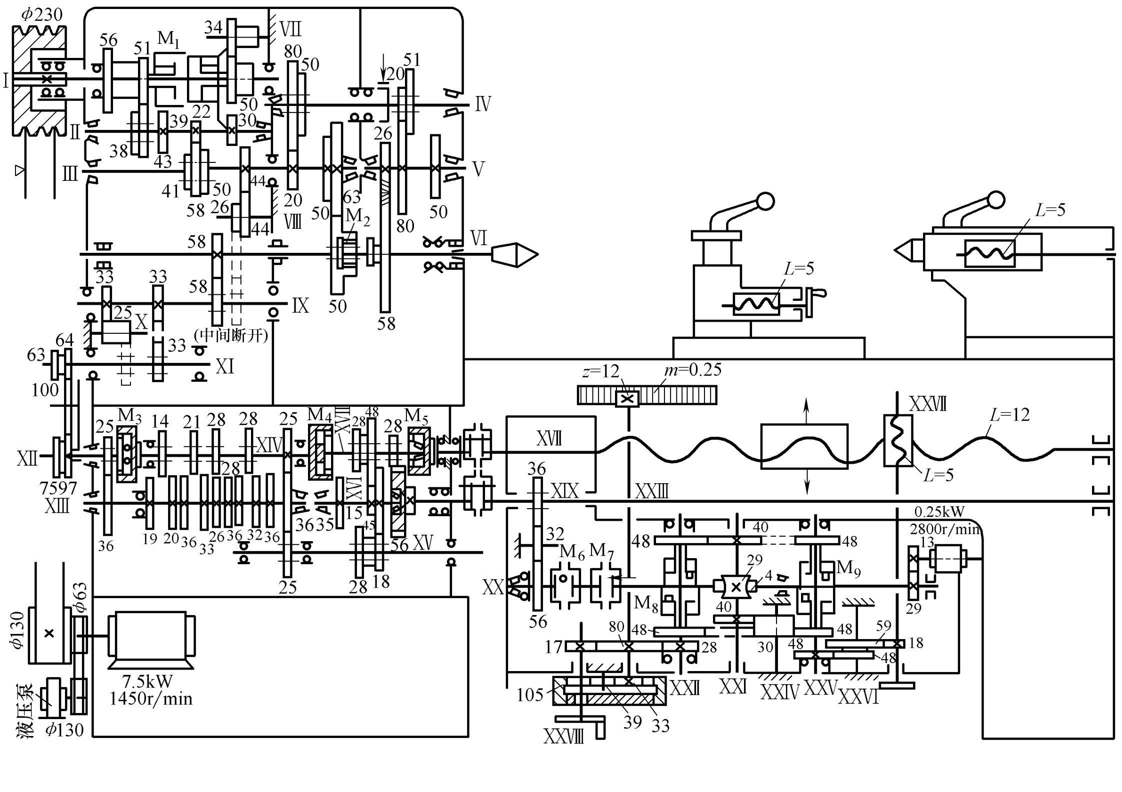


Fig. 2-2 Transmission system diagram of the lathe CA6140 CA6140 型车床传动系统图

(3) Module thread: $m=3.5$mm, $n=2$.

Try to write out its transmission route expression, and indicate the spindle revolution range used in cutting these threads.

在 CA6140 型车床上车削下列螺纹：

(1) 米制螺纹：$P=3$mm，$n=2$。

(2) 英制螺纹：$a=4$ 牙/in。

（3）模数制螺纹：$m=3.5\text{mm}$，$n=2$。

试写出其传动路线表达式，并说明车削这些螺纹时可采用的主轴转速范围。

4. Suppose the metric thread with lead $P_h=10\text{mm}$ is to be cut on the lathe CA6140. What transmission routes can be used to cut this kind of thread?

欲在 CA6140 型卧式车床上加工导程 $P_h=10\text{mm}$ 的米制螺纹，试指出哪些传动路线能够加工这一螺纹。

5. Could the transmission chain used to cut the large lead threads be used to cut the precise non-standard threads on the lathe CA6140?

能否在 CA6140 型车床上，用车大导程螺纹的传动链车削较精密的非标准螺纹？

6. According to the transmission principle diagram of the gear hobbing machine shown in Fig. 2.3 a and b, answer the following questions:

（1）How many transmission chains in straight gear hobbing ? What are they?

（2）How many transmission chains in helical gear hobbing ? What are they?

（3）Which motion is the simple forming motion? Which motion is the compound forming motion?

（4）What does the u_v, u_x, u_f, u_y mean in the transmission chains of the gear hobbing?

根据图 2-3 a 和 b 所示滚齿机传动原理图，回到下列问题：

（1）滚切直齿圆柱齿轮有几条传动链？都是哪几条？

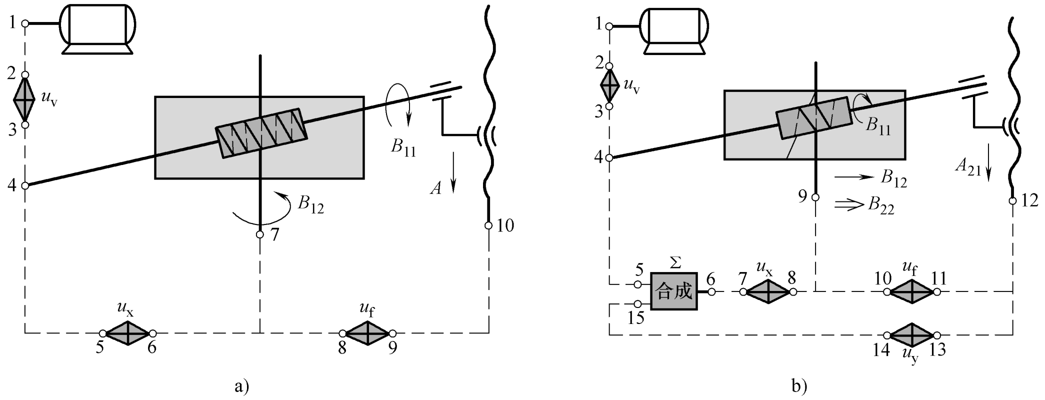


Fig. 2-3 Transmission principle diagram of gear hobbing machine 滚齿机传动原理图

（2）滚切斜齿圆柱齿轮有几条传动链？都是哪几条？

（3）哪个运动是简单运动？哪个运动是复合运动？

（4）在滚齿机传动链中，u_v、u_x、u_f、u_y 分别指的是什么？

7. A single-thread right-hand hob with 55mm in diameter is used to cut a right-hand helical gear with $z=80$, $m_n=2$mm, $\beta=12°17'9''$ on the gear hobbing machine Y3150E. The cutting speed $v=22$m/min, axial feed $f=1$mm/r.

(1) To draw the sketch of hob installation.

(2) To write out the motion balance equation of each transmission chain.

(3) To determine the tooth number of each change gear.

在 Y3150E 型滚齿机上用直径为 55mm 的单头右旋滚刀滚切 $z=80$、$m_n=2$mm，$\beta=12°17'9''$的右旋斜齿轮。切削速度 $v=22$m/min，轴向进给量$f=1$mm/r。

（1）绘制滚刀安装示意图。

（2）写出每条传动链的运动平衡方程式。

（3）确定每个交换齿轮的齿数。

8. Why are there two reversing mechanisms in the headstock of the lathe CA6140? Whether one of them can be canceled or not? What are the functions of the reversing mechanisms in apron?

为什么在 CA6140 型车床主轴箱中有两个换向机构？能否取消其中一个？溜板箱内的换向机构又有什么用处？

9. Under any of following condition (other conditions are kept unchanged), which reversing mechanism of transmission chain in a hobbing gear machine must be operated?

1) Hobbing right-hand gear→hobbing left-hand gear.

2) Up hobbing→down hobbing.

3) Using right-hand hob→using left-hand hob.

在下列任一种情况下（其他条件不改变），滚齿机上哪些传动链的换向机构要变向？

1）由滚切右旋齿轮改为左旋齿轮。

2）由逆铣滚齿改为顺铣滚齿。

3）由使用右旋滚刀改为左旋滚刀。

10. Make a comparison of the various gear machining methods in terms of their application, accuracy and process.

就用途、加工精度和加工工艺对各种齿轮加工方法进行比较。

11. List those machine tools which can be used to machine external cylindrical surfaces, holes, planes and grooves (or slots) respectively, and point out their application range.

列出所有分别可用来加工外圆表面、内孔、平面和沟槽的各种机床，并指出它们各自的适用范围。

Chapter 3

Machining Process Planning

第3章

机械加工工艺的制订

3.1 English-Chinese Terms 名词英汉对照

1. production process 生产过程
2. process 工艺过程
3. machining process 机械加工工艺过程
4. machine assembling process 机械装配工艺过程
5. operation 工序
6. working position 工位
7. operation datum 工序基准
8. location datum 定位基准
9. working step 工步
10. rough datum 粗基准
11. finish datum 精基准
12. production program 生产纲领
13. economical machining accuracy 经济加工精度
14. process concentration 工序集中
15. process dispersal 工序分散
16. machining allowance 加工余量
17. dimensional chain 尺寸链
18. closing link 封闭环
19. increasing link 增环
20. decreasing link 减环

3.2 Filling in the blanks 填空题

1. Process datums can be divided into operation datum, ____________, ____________ and assembly datum.

工艺基准可以分为工序基准、____________、____________和装配基准。

2. According to the production specialization degree of a factory, production type is classified as three kinds: ____________, ____________ and ____________. The dividing of production type has to do with ____________, besides, ____________ should also be considered.

根据工厂生产专业化程度不同，生产类型可分为____________、____________和____________三种。生产类型的划分除了与____________有关外，还应考虑____________。

3. The technical requirements for the workpiece surfaces to be machined are dimension accuracy, form accuracy, ____________ and ____________.

零件加工表面的技术要求有尺寸精度、形状精度、____________和____________。

4. Common blank types are ______________, ______________, ______________ and ____________.

常见毛坯种类有____________、____________、____________和____________。

5. Location methods of a workpiece are ____________, ____________ and ____________.

工件的定位方法有____________、____________和____________三种。

6. Generally, the process is divided into four machining phases: ____________, ____________, ____________ and ____________.

工艺过程一般划分为____________、____________、____________和____________四个加工阶段。

7. Two features of the technological dimension al chain are ____________ and ____________.

工艺尺寸链的两个特征是____________和____________。

8. Single-piece time consists of basic time, ____________, ____________, relax and physiological need time and ____________.

单件时间包括基本时间、____________、____________、休息和生理需要时间和____________。

9. Based on the functions, the datum is divided into two broad classifications: ____________ and ____________. Location datum belongs to ____________。

根据作用的不同，基准通常可分为____________和____________两大类。定位基准属于____________。

10. The methods to determine machining allowance are ____________, ____________ and ____________.

确定毛坯加工余量的方法有____________、____________和____________三种。

11. In order to ensure machining quality, the principle to arrange machining sequence is ____________, ____________, ____________ and ____________.

为了保证加工质量，安排机械加工顺序的原则是____________、____________、____________和____________。

12. When choosing the rough datum, the emphases are to consider as follows: ① each surface to be machined should have an adequate and uniform ____________; ② to ensure ____________ between machined surface and unfinished surface.

选择粗基准时要考虑：① 使各加工面都有一定且比较均匀的____________；

② 保证加工面与非加工面的____________。

3.3 Making choice 选择题

1. A shaft is machined successively by means of a lathe and a grinding machine. The process should be divided into ____.

A. two operations　　B. two working steps

C. two working positions　　D. one compound working step

先后在车床和磨床上加工一根轴。该工艺过程应分成____。

A. 两道工序　　B. 两个工步　　C. 两个工位　　D. 一个复合工步

2. A hole is machined successively by drilling and reaming on a drilling machine. The process should be divided into ____.

A. two operations B. two working steps

C. two working positions D. one compound working step

在一台钻床上先后钻、铰一个孔。该工艺过程应分成____。

A. 两道工序 B. 两个工步 C. 两个工位 D. 一个复合工步

3. Generally, the heat treatment between rough machining and semi-finishing is ____。

A. normalizing B. nitriding

C. quenching and tempering D. carburizing

通常，粗加工和半精加工之间的热处理是____。

A. 正火 B. 渗氮处理 C. 调质 D. 渗碳

4. Generally, the last operation in a workpiece machining process is ____.

A. finish grinding B. nitriding C. cleaning D. inspection

通常，工件加工过程的最后一道工序是____。

A. 精磨 B. 渗氮处理 C. 清洗 D. 检验

5. In machining, the process in which the shape, dimension and surface quality of the workpiece are directly changed into desired ones is called ____ .

A. production process B. process

C. procedure D. machining process

在机械加工中直接改变工件的形状、尺寸和表面质量，使之成为所需零件的过程称为____。

A. 生产过程 B. 工艺过程

C. 工艺规程 D. 机械加工工艺过程

6. The most basic element in the machining process is ____.

A. working step B. operation C. working position D. installation

机械加工工艺过程中最基本的单元是____。

A. 工步 B. 工序 C. 工位 D. 安装

7. Self-location datum is often used in the finishing or finishing cut operation so as to ____.

A. accord with the "datum unification" B. accord with the "datum coincidence"

C. ensure small and even machining allowance D. ensure the form and position accuracy

自为基准多用于精加工或光整加工工序中，以便____。

A. 符合基准统一原则 B. 符合基准重合原则

C. 能保证加工面余量小而均匀 D. 能保证加工面形状和位置精度

8. In machining, the time required in completing one operation of a workpiece is called ____.

A. basic time B. working time C. single-piece time D. service time

在机械加工中，完成一个工件的一道工序所需的时间称为____。

A. 基本时间 B. 工作时间 C. 单件时间 D. 服务时间

9. The blanks of important shafts use ____ generally.

A. castings B. forgings C. bar stocks D. tubular products

重要的轴类零件的毛坯通常应选择____。

A. 铸件　B. 锻件　C. 棒料　D. 管材

10. The blanks of the bed of general machine tool use ____ generally.

A. castings　B. forgings　C. welded elements　D. stamping parts

普通机床床身的毛坯多采用____。

A. 铸件　B. 锻件　C. 焊接件　D. 冲压件

11. Datum coincidence principle means using ____ datum as a finish datum.

A. design　B. operation　C. measurement　D. assembly

基准重合原则是指使用被加工表面的____基准作为精基准。

A. 设计　B. 工序　C. 测量　D. 装配

12. Box-type workpieces often use ____ as unified finish datum.

A. one surface and one hole　B. one surface and two holes

C. two surfaces and one hole　D. two surfaces and two holes

箱体类零件常采用____作为统一精基准。

A. 一面一孔　B. 一面两孔　C. 两面一孔　D. 两面两孔

13. Usually, for the workpiece made of copper alloy, the machining route of cylindrical surface with IT7 is ____ .

A. rough turning—semi-finish turning

B. rough turning—semi-finish turning—finish turning

C. rough turning

D. rough turning—semi-finish turning—finish grinding

材料为铜合金，精度为 IT7 的外圆表面加工通常采用____的加工路线。

A. 粗车—半精车　B. 粗车—半精车—精车

C. 粗车　D. 粗车—半精车—精磨

14. Usually, for the workpiece made of hardened steel, the machining route of cylindrical surface with IT7 is ____ .

A. rough turning—semi-finish turning—finish turning

B. rough turning—semi-finish turning—finish turning—diamond turning

C. rough turning—semi-finish turning—rough grinding

D. rough turning—semi-finish turning—rough grinding—finish grinding

材料为淬火钢，精度为 IT7 的外圆表面常采用的加工路线是____。

A. 粗车—半精车—精车　B. 粗车—半精车—精车—金刚石车

C. 粗车—半精车—粗磨　D. 粗车—半精车—粗磨—精磨

15. For the box body made of cast iron, the common used machining route of a hole with ϕ120H7 is ____ .

A. rough boring—semi-finish boring—finish boring

B. rough boring—semi-finish boring—reaming

C. rough boring—semi-finish boring—rough grinding

D. rough boring—semi-finish boring—rough grinding—finish grinding

铸铁箱体上 ϕ120H7 孔常采用的加工路线是____。

A. 粗镗—半精镗—精镗　　B. 粗镗—半精镗—铰

C. 粗镗—半精镗—粗磨　　D. 粗镗—半精镗—粗磨—精磨

16. In dimensional chain, suppose other component links are constant, the increase of a decreasing link would cause the closing link to ____ .

A. increase　B. decrease　C. keep constant　D. increase or decrease

尺寸链其余组成环不变，某一减环的增大使封闭环____。

A. 增大　B. 减小　C. 保持不变　D. 可大可小

17. When selecting rough datum, if the important surface must have an even machining allowance, then the rough datum should be ____ .

A. the surface with small machining allowance　B. the important surface to be machined

C. the semi-finished surface　D. the arbitrary surface

选择粗基准时，若要保证某重要表面余量均匀，则应选择____。

A. 余量小的表面　B. 该重要表面　C. 半精加工表面　D. 任意表面

18. The quenching and tempering should be arranged ____ .

A. before rouging　B. between roughing and semi-finishing

C. after finishing　D. the arbitrary operation

调质处理一般应安排在____。

A. 粗加工前　B. 粗加工与半精加工之间

C. 精加工之后　D. 任意工序

19. Before nitriding treatment, ____ have to be arranged.

A. normalizing　B. quenching and tempering

C. surface quenching　D. carburizing

零件氮化处理前必须安排的热处理是____。

A. 正火　B. 调质　C. 表面淬火　D. 渗碳

20. In mass production, the machine tool used for boring the bearing hole in box is ____ .

A. horizontal boring machine　B. vertical lathe

C. special-purpose modular boring machine　D. milling machine

大批生产中，镗箱体轴承孔的机床宜选用____。

A. 卧式镗床　B. 立式车床　C. 专用组合镗床　D. 铣床

21. In order to improve the gear machining efficiency, ____ should be selected for the sector gears with small module, small width and machining accuracy being grade 7~8.

A. gear hobbing　B. gear shaping　C. gear milling　D. gear grinding

为提高齿轮加工效率，对于模数小和精度为 7~8 级齿宽较小的扇形齿轮常采用____。

A. 滚齿　B. 插齿　C. 铣齿　D. 磨齿

22. After the gear teeth are hardened, the finishing method with the higher efficiency is ____ .

A. gear hobbing　B. gear shaving　C. gear honing　D. gear grinding

齿轮轮齿经淬硬处理后进行精加工，效率较高的方法是____。

A. 滚齿　　B. 剃齿　　C. 珩齿　　D. 磨齿

23. For the unhardened tooth's surface, the common used finishing method is ____.

A. gear milling　　B. gear shaving　　C. gear honing　　D. gear grinding

未淬硬齿面常用的精加工方法是____。

A. 铣齿　　B. 剃齿　　C. 珩齿　　D. 磨齿

24. The method for machining internal gear is ____.

A. gear hobbing　　B. gear shaping　　C. gear honing　　D. gear grinding

内齿轮齿形的加工方法是____。

A. 滚齿　　B. 插齿　　C. 剃齿　　D. 磨齿

3.4 True or false 判断题

1. A working step is a basic element of process. (　　)

工步是组成工艺过程的基本单元。(　　)

2. It's not allowed to use rough datum repeatedly. (　　)

绝对不允许重复使用粗基准。(　　)

3. The basic element of process is operation. (　　)

工序是组成工艺过程的基本单元。(　　)

4. The rough datum can be used repeatedly in the same dimension direction. (　　)

粗基准在同一尺寸方向可以反复使用。(　　)

5. It must have increasing link and decreasing link in the linear dimensional chains. (　　)

直线尺寸链中必须有增环和减环。(　　)

6. Two center holes are often used as the location datum of the shafts. This accords with the principle of self-location datum. (　　)

轴类零件常用两个中心孔定位，符合“自为基准”原则。(　　)

7. The shaft-type workpiece often use its cylindrical surface as unified finish datum. (　　)

轴类零件常使用其外圆表面作为统一精基准。(　　)

8. The component links in dimensional chain are generally obtained directly in machining process. (　　)

工艺尺寸链的组成环一般是在加工过程中直接得到的。(　　)

9. Variable expense in process cost has nothing to do with the annual output. (　　)

在工艺成本中，可变费用是与年产量无关的费用。(　　)

10. Generally, auxiliary operations are not the important operations. (　　)

辅助工序通常都不是重要的工序。(　　)

3.5 Short-answer questions 简答题

1. How many production types are there? What are they? What are technological characteristics of different production types?

有几种生产类型？分别是什么？各生产类型各有什么工艺特点？

2. What is the machining process rule? What functions does it has in production?
什么是机械加工工艺规程？工艺规程在生产中起什么作用？

3. What are the principles of selecting the rough, finish datum?
选择粗基准和精基准的原则有哪些？

4. What is datum coincidence principle? What is unified datum principle?
何谓基准重合原则？何谓基准统一原则？

5. What is the economical machining accuracy? What are the principles in the selection of surface machining methods?
何谓经济加工精度？选择表面加工方法的原则有哪些？

6. What is machining allowance? What are the factors influencing on machining allowance?
什么是加工余量？影响加工余量的因素有哪些？

7. How many machining stages are divided generally in machining process? Why machining stage should be divided?
机械加工过程通常划分为哪几个加工阶段？为什么要划分加工阶段？

8. What is operation concentration? What is operation dispersal? What are their features?
什么是工序集中和工序分散？各有什么特点？

9. What are the principles in the arrangement of machining operation? How do you understand "to machine the datum surfaces first, then other surfaces"? How do you understand "to arrange the major surfaces first, then the minor surfaces"?
安排机械加工工序的原则是什么？如何理解"先基面，后其他"？如何理解"先主后次"？

11. What is dimensional chain? What is increasing link, decreasing link and closing link? What features does dimensional chain have?

什么是尺寸链？什么是增环、减环和封闭环？尺寸链的特征是什么？

12. What is time rating? What is the single-piece time? How to calculate the single-piece time?

何谓时间定额？何谓单件时间？如何计算单件时间？

13. What is process cost? What are the elements of process cost?

什么是工艺成本？工艺成本由哪些部分组成？

3.6 Analysis and calculation 分析与计算题

1. Try to point out the problems in structural machinability presented in Fig. 3-1, and propose the improving ideas.

试指出图 3-1 中结构工艺性方面存在的问题，并提出改进意见。

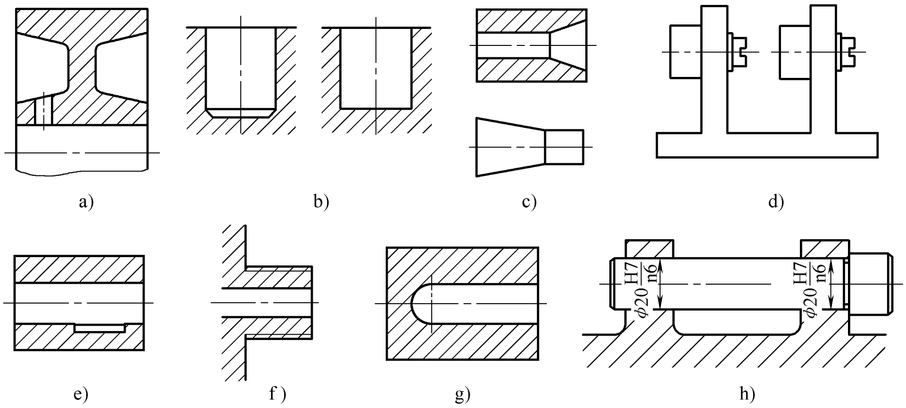


Fig. 3-1 Analysis of structural machinability 结构工艺性分析

2. A kind of workpiece in job production is shown in Fig. 3-2. Its machining contents are as follows: ①to cut six surfaces on a double column planning machine in light of requirements for the workpiece; ②to cut the surface *A* of the guide way in two times by rough planning; ③to cut two recesses; ④to cut the surface *A* by finish planning; ⑤drilling; ⑥core drilling; ⑦reaming; ⑧deburring. Analyze its elements of the machining process (including operations, working steps, feed and set-up).

单件生产的某种零件如图 3-2 所示。其加工内容如下：①按照工件的加工要求在龙门刨床上刨削六个表面；②分两次粗刨导轨面“*A*；③刨削两个越程槽；④精刨导轨面 *A*；⑤钻孔；⑥扩孔；⑦铰孔；⑧去毛刺。试分析其工艺过程的组成（包括工序、工步、进给和装夹等）。

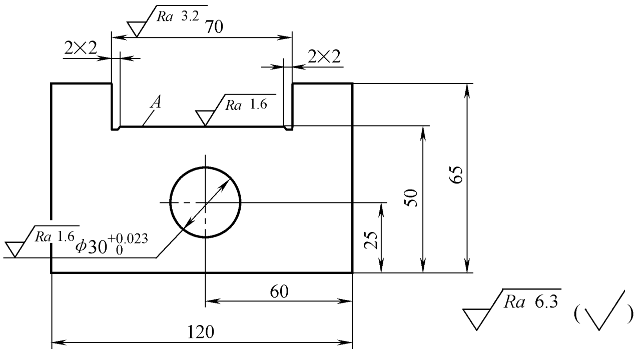


Fig. 3-2 A block of the guide way 导轨块

3. A kind of workpiece in batch production is shown in Fig. 3-3. The blank is a stock with ϕ35mm in diameter. Its machining process is as follows: ①cutting one end face and drilling a center hole; ②cutting another end face and drilling another centre hole; ③turning the cylindrical surface to ϕ30mm in diameter in another lathe of the whole batch of workpieces; ④holding another end to turn the cylindrical surface to ϕ18mm in diameter of the whole batch of workpieces; ⑤turning the cylindrical surface to ϕ20mm in diameter on another lathe; ⑥cutting two parallel surfaces on a milling machine, then rotate 90°, cutting other two parallel surfaces on the same milling machine; ⑦ thread turning and chamfering. Analyze its elements of the machining process (including operation, working step, feed and set-up).

图 3-3 所示零件以批量生产。毛坯为 ϕ35mm 的棒料。其加工过程如下：①车一端面，打中心孔；②车另一端面，打中心孔；③在另一台车床上车整批零件的外圆至 ϕ30mm；④调头，夹持另一端车整批零件的外圆至 ϕ18mm；⑤在另一台车床上车外圆至 ϕ20mm；⑥在铣床上铣两平行平面，然后转位 90°，在同一台铣床上铣另外两个平行平面；⑦车螺纹，倒角。试分析其工艺过程的组成（包括工序、工步、进给和装夹等）。

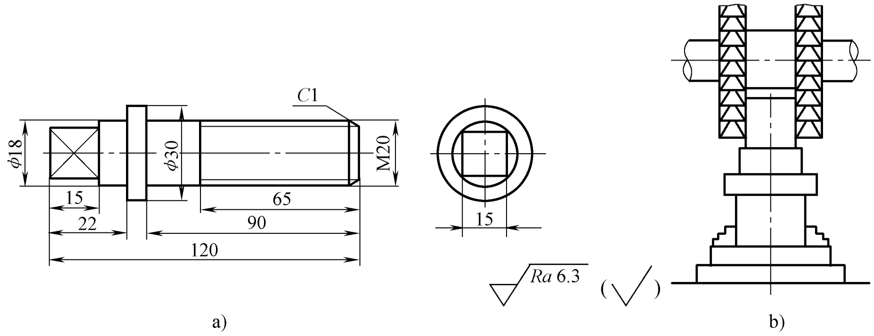


Fig. 3-3 Square-head screw 方头螺杆

4. The annual output of the Model 6105 gasoline engines of a factory is 10000 pieces. The spared rate of the linkages is given to be 8%, and the reject rate is 2%. What is the production program of the linkages? What is about its production type?

某厂 6105 型汽油发动机的年产量为 10000 台。连杆的备品率为 8%，废品率为 2%。连杆的生产纲领是多大？属于何种生产类型？

5. Try to select the rough and finish datums of the flywheel shown in Fig. 3-4, and explain the reason.

试选择图 3-4 所示飞轮零件的粗、精基准，并解释这样选择的理由。

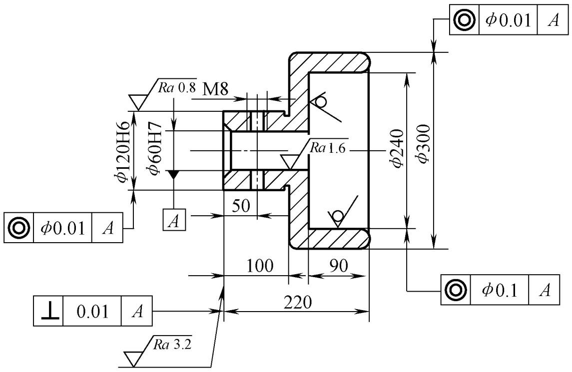
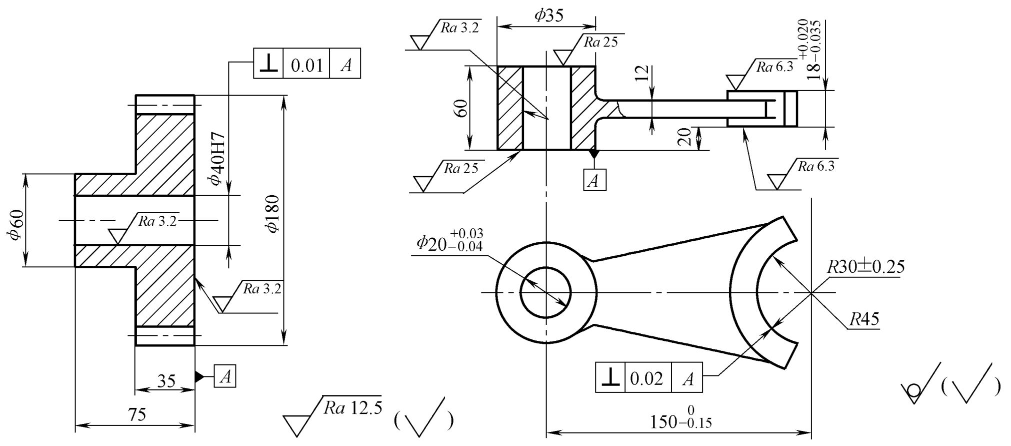


Fig. 3-4 Flywheel 飞轮

6. Try to select the rough and finish datum of the workpieces shown in Fig. 3-5, and explain the reason.

试选择图 3-5 所示零件的粗、精基准，并解释这样选择的理由。

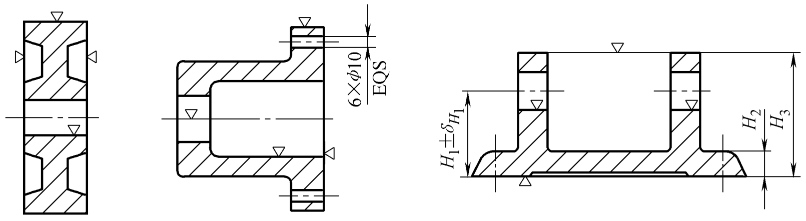


a) b)

Fig. 3-5 Select the rough and finish datum（1）粗、精基准选择（1）

7. Try to select the rough and finish datum of the workpieces shown in Fig. 3-6, and explain the reason. (The symbol D refers to the surface to be machined, the others are non-machined surface. The requirement of Fig. 3-6a and b is to ensure the uniform wall thickness.)

试选择图 3-6 所示零件的粗、精基准，并解释这样选择的理由（标有符号▽为加工面，其余为非加工面。其中图 3-6a、b 要求保持壁厚均匀）。



a) b) c)

Fig. 3-6 Select the rough and finish datum（2）粗、精基准选择（2）

8. There is a hole with $\phi 60^{+0.03}_{0}$ mm in diameter and 60mm long on a workpiece, and its surface roughness Ra is 1.6μm. Given that the blank is forging part, its material is 45 steel, the hardness is 42 HRC after quenching. Suppose the machining process of the hole is rough boring→semi-finish boring→quenching→grinding holes. Try to find each operation dimension and its deviations.

某零件上有一孔 $\phi 60^{+0.03}_{0}$mm，表面粗糙度 Ra 为 1.6μm，孔长 60mm，材料为 45 钢，淬火硬度值 42HRC，毛坯为锻件。设孔的加工工艺过程是：①粗镗；②半精镗；③淬火；④磨孔。试求各工序尺寸及其偏差。

9. When machining a workpiece shown as following Fig. 3-7, the design dimension（6±0.1）

mm should be ensured. As the dimension is difficult to measure, it only can be obtained indirectly by controlling L. Try to find L and its limit deviations。

加工图 3-7 所示工件时，必须保证设计尺寸（6±0. 1）mm。由于该尺寸不便测量，只能通过控制尺寸 L 间接保证。试求尺寸 L 及其极限偏差。

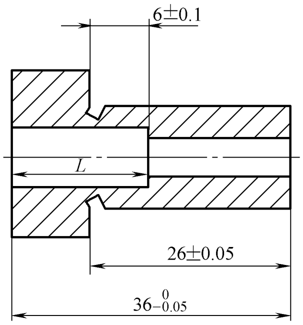


Fig. 3-7 Sleeve 套筒

10. There is a box-type part as shown in Fig. 3-8. Given that the surfaces A, B and C have been machined to the requisite accuracy. The design dimension (120±0. 15) mm have to be ensured after boring. Choose the surface A as location datum. Since the (120±0. 15)mm can't be measured easily, try to find L。

图 3-8 所示的箱体零件中，已知表面 A、B 和 C 均已加工好。镗孔后必须保证设计尺寸（120±0. 15)mm。镗孔时以表面 A 作为定位基准。由于尺寸（120±0. 15)mm 不易测量，试求 L。

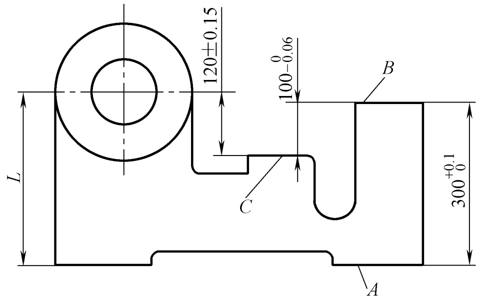


Fig. 3-8 Box type part 箱体零件

11. As shown in Fig. 3-9, $\phi40^{+0.05}_{0}$ mm and $46^{+0.3}_{0}$ are the design dimensions. Machining sequence of the hole and the keyway is as follows: ①boring a hole to $\phi39.6^{+0.1}_{0}$ mm; ②slotting a keyway to the dimension A; ③heat treatment; ④grinding the hole to $\phi40^{+0.05}_{0}$ mm, and $46^{+0.3}_{0}$ mm is also got indirectly at the same time. Find the operation dimension A and its limit deviations.

如图 3-9 所示，$\phi40^{+0.05}_{0}$ mm 和 $46^{+0.3}_{0}$ mm 是设计尺寸。内孔及键槽的加工顺序为：①镗孔至 $\phi39.6^{+0.1}_{0}$ mm；②插键槽至尺寸 A；③热处理；④磨内孔至 $\phi40^{+0.05}_{0}$ mm，同时间接获得 $46^{+0.3}_{0}$ mm。试求出插键槽的工序尺寸 A 及其极限偏差。

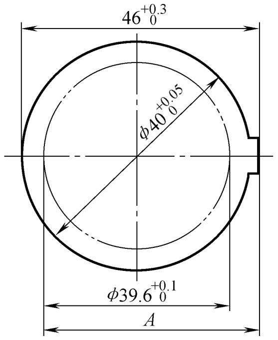


Fig. 3-9 Machning of the hole and the slot
内孔及键槽的加工

12. A sleeve-type workpiece is to be machined, its axial dimensions are shown in Fig. 3-10a. Its operation drawings are illustrated in Fig. 3-10b and c. Try to find the operation dimensions L_1, L_2 and its limit deviations.

欲加工一套筒零件，其轴向尺寸如图 3-10a 所示，有关工序简图如图 3-10b、c 所示。试求工序尺寸 L_1 和 L_2 及其极限偏差。

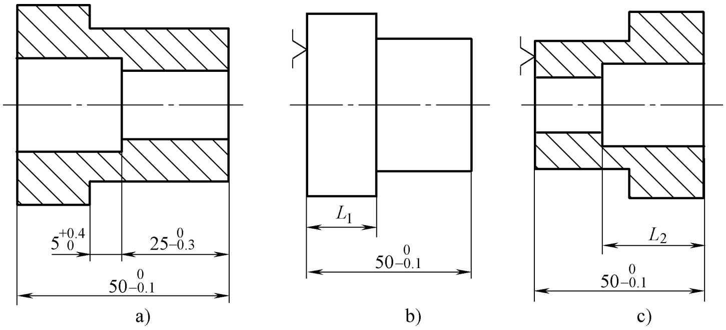


Fig. 3-10 A sleeve and its operation 套筒及其加工工序

13. A sleeve-type workpiece is to be machined, its axial dimensions are shown in Fig. 3-11a. Its operation drawings are illustrated in Fig. 3-11b and c. Try to find the operation dimensions L_1, L_2 and its limit deviations.

欲加工一套筒零件，其轴向尺寸如图 3-11a 所示，有关工序简图如图 3-11b、c 所示。试求工序尺寸 L_1 和 L_2 及其极限偏差。

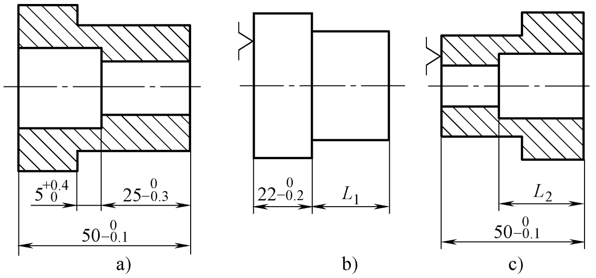


Fig. 3-11 Sleeve 套筒

14. As shown in Fig. 3-12, $\phi 28^{+0.024}_{+0.008}$mm and $4^{+0.15}_{0}$mm are the design dimensions. Machining sequence is as follows: ① turning the shaft to dimension$\phi 28.5^{0}_{-0.1}$mm; ②to mill a keyway to dimension $H^{+0.16}_{0}$mm; ③heat treatment; ④grinding the shaft to dimension $\phi 28^{+0.024}_{+0.008}$mm. Find H and its limit deviations.

如图 3-12 所示，$\phi 28^{+0.024}_{+0.008}$mm 和 $4^{+0.15}_{0}$mm 为设计尺寸。加工顺序如下：①车外圆至 $\phi 28.5^{0}_{-0.10}$mm；②在铣床上铣键槽，键深尺寸为 $4^{+0.16}_{0}$mm；③淬火热处理；④磨外圆至尺寸 $\phi 28^{+0.024}_{+0.008}$mm。试计算铣键槽的工序尺寸 H 及其极限偏差。

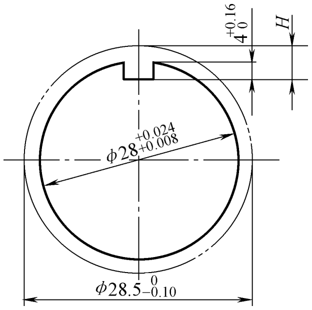


Fig. 3-12 Machining of the shaft with keyway 加工带有键槽的轴

15. A sleeve is shown in Fig. 3-13. Given that surface B, C, D have been machined well, surface A is to be machined on a milling machine, and the dimension $10^{+0.20}_{0}$mm has to be ensured. Suppose the surface D is selected as location datum, and the adjusting method is used, try to indicate the operation dimension of this operation.

如图 3-13 所示的套筒零件，已知 B、C、D 面均以加工好，本道工序在铣床上以 D 面定位采用调整法加工表面 A，保证尺寸 $1^{+0.20}_{0}$mm。试标注此工序的工序尺寸。

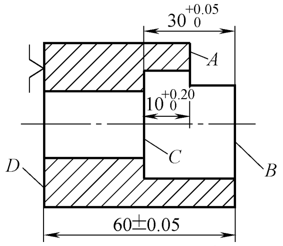


Fig. 3-13 Sleeve 套筒

16. A workpiece is shown in Fig. 3-14. Given that the surface M and N as well as the hole (ϕ25H8) have been machined well, try to find the dimension which is easy to measure when machining surface K. indicate the dimension on operation drawing, and analyze what influence of this indiration on process is.

图 3-14 所示零件的 M、N 面及 ϕ25H8 孔均已加工，试求加工 K 面时便于测量的测量尺

寸。将求出的数值标注在工序草图上，并分析这种标注对零件的工艺过程有何影响。

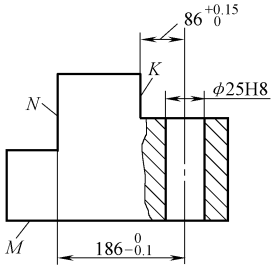


Fig. 3-14　Base 底座

17. A sleeve-type workpiece is shown in Fig. 3-15a. The two dimensions $38_{-0.1}^{0}$ mm and $8_{-0.05}^{0}$ mm have been obtained in previous operations. There are three location schemes which can be used for drilling hole, as shown in Fig. 3-15b, c and d respectively. Try to calculate the three operational dimensions A_1, A_2 and A_3 respectively.

图 3-15a 所示为一轴套零件，尺寸 $38_{-0.1}^{0}$mm 和 $8_{-0.05}^{0}$mm 已加工好，图 3-15b、c、d 为钻孔加工时三种定位方案的简图。试计算三种定位方案的工序尺寸 A_1、A_2 和 A_3。

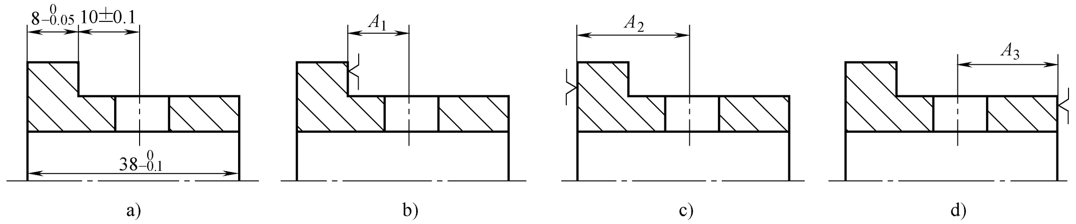


Fig. 3-15　Sleeve-type workpiece 轴套零件

18. A bearing seat is shown in Fig. 3-16. Given that $\phi50_{0}^{+0.03}$mm has been machined, now the dimension (75±0.05)mm is to be measured. As the dimension is difficult to measure, it is determined to measure H. Try to calculate H and its limit deviations.

图 3-16 所示为轴承座零件，$\phi50_{0}^{+0.03}$mm 孔已加工好，现要测量尺寸（75±0.05）mm。由于该尺寸不好直接测量，故改测尺寸 H。试计算尺寸 H 的大小及极限偏差。

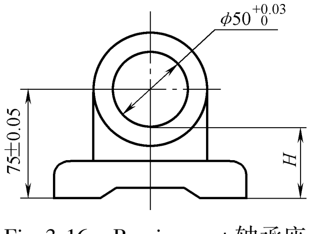


Fig. 3-16　Bearing seat 轴承座

19. A workpiece is shown in Fig. 3-17. In order to ensure the design dimension $5_{0}^{+0.2}$mm, the face 1 is taken as the measuring datum in grooving, the hole depth A is controlled. Try to calculate

the operation dimension A and its limit deviations.

为保证图 3-17 所示零件中设计尺寸 $5^{+0.2}_{0}$mm 的要求，切槽时以端面 1 为测量基准，控制孔深 A。试求工序尺寸 A 及其极限偏差。

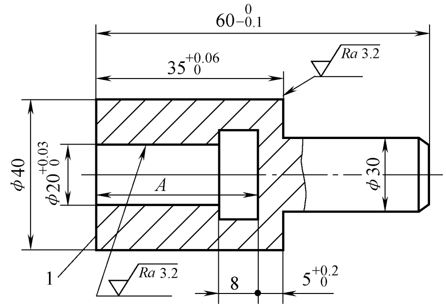


Fig. 3-17 Step shaft with blind hole
带有不通孔的阶梯轴

20. A sleeve-type workpiece is shown in Fig. 3-18, and the external cylindrical surface, the hole and the other surfaces have machined well on a lathe. Now the slot on the right side is to be cut on a milling machine, and $5^{\ 0}_{-0.06}$mm and (26±0.2) mm must be ensured. Try to find the measuring dimensions H, A and their limit deviations for tool setting in trial cutting.

图 3-18 所示为轴套零件，在车床上已加工好外圆、内孔及各面，现要在铣床上铣出右端槽，并保证尺寸 $5^{\ 0}_{-0.06}$mm 及（26±0.2）mm，求试切调刀时的度量尺寸 H、A 及其极限偏差。

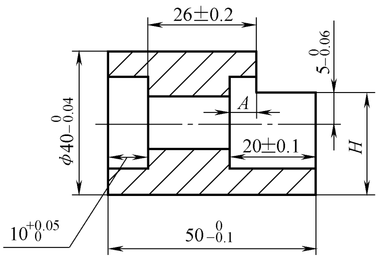


Fig. 3-18 Sleeve-type workpiece 轴套零件

21. A box-type workpiece is shown in Fig. 3-19 (the related dimensions are indicated only), try to analyze and calculate:

(1) If both hole O_1 and hole O_2 are bored by taking the surface M as location datum, try to find the operation dimensions in boring two holes.

(2) When inspecting the distance between two holes, because (80±0.08) mm is difficult to measure, A_1 is measured. Try to find the operation dimension A_1 and its limit deviations.

(3) If it is fouud by inspection that A_1 is out of tolerance, could you directly judge the work-piece is a reject?

图 3-19 所示为箱体零件（图中只标注了有关尺寸），试分析计算：

(1) 若孔 O_1、O_2 都以 M 面为基准镗削，试求镗两孔时的工序尺寸。

(2) 检验孔距时，因 (80±0.08)mm 不便于测量，故选测量尺寸 A_1，试求工序尺寸 A_1 及其极限偏差。

(3) 若实测尺寸 A_1 超差了，能否直接判断该零件为废品？

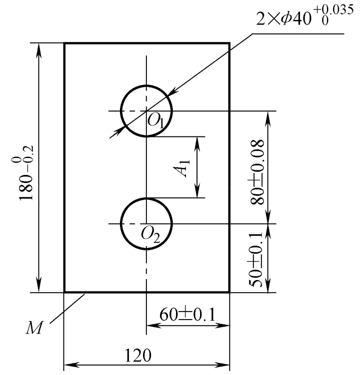


Fig. 3-19 Box-type workport 箱体零件

22. Fig. 3-20 shows a liner bushing made of 20 steel. It is required for the hole with $\phi\, 30^{+0.021}_{0}$ mm in diameter that the depth of carburizing layer should be $0.8^{+0.03}_{0}$ mm after grinding. Try to find:

(1) The operation dimension and its limit deviations of finish boring before grinding。

(2) The depth of carburizing layer and its limit deviations in heat treatment after finish boring.

图 3-20 所示衬套的材料为 20 钢，$\phi 30^{+0.021}_{0}$ mm 内孔表面要求磨削后保证渗碳层深度 $0.8^{+0.03}_{0}$ mm。试求：

(1) 磨削前精镗工序的工序尺寸及极限偏差。

(2) 精镗后热处理时渗碳层的深度尺寸及其极限偏差。

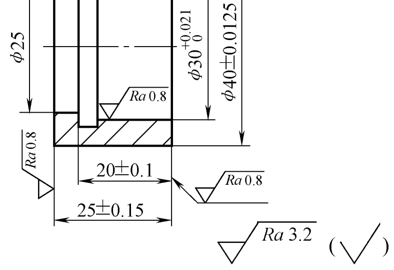


Fig. 3-20 Liner bushing 衬套

23. Fig. 3-21 shows a transmission shaft of a vane pump. The technological process of the shaft is as follows: ① cutting the cylindrical surface to $\phi 26_{-0.28}^{\ 0}$mm by rough turning; ② cutting the cylindrical surface to $\phi 25.3_{-0.084}^{\ 0}$mm by finish turning; ③ lineation for milling the keyway; ④ milling the keyway to the depth A; ⑤ carburizing to the depth t, then quenchine to 56~62HRC; ⑥ grinding the cylindrical surface to $\phi 25_{-0.14}^{\ 0}$mm, and the depth of carburizing layer should be kept in 0.9~1.1 mm. Try to find:

(1) The keyway depth A and its limit deviations in keyway milling.

(2) The depth t and its limit deviations of carburizing layer.

图 3-21 所示叶片泵传动轴的工艺过程如下：①粗车外圆至 $\phi 26_{-0.28}^{\ 0}$mm；②精车外圆至 $\phi 25.3_{-0.084}^{\ 0}$mm；③划键槽线；④铣键槽深度至尺寸 A；⑤渗碳深度 t，淬火至 56~62HRC；⑥磨外圆至尺寸 $\phi 25_{-0.14}^{\ 0}$mm，要求保证渗碳层深度 0.9~1.1mm。试求：

(1) 铣键槽深度尺寸 A 及其极限偏差。

(2) 渗碳层深度 t 及其极限偏差。

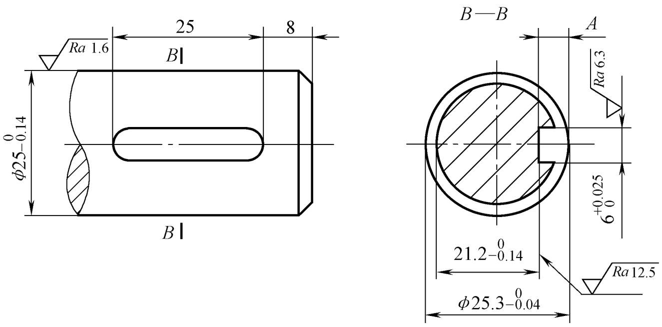


Fig. 3-21 Transmission shaft 传动轴

24. The requirements for the final dimensions of the workpiece are shown in Fig. 3-22a. The machining sequence of the workpiece is shown in Fig. 3-22b-e, try to find the drilling operation dimension F and its limit deviations.

某零件的最终尺寸要求如图 3-22a 所示。该零件的加工顺序如图 3-22b~e 所示。试求钻孔工序尺寸 F 及其极限偏差。

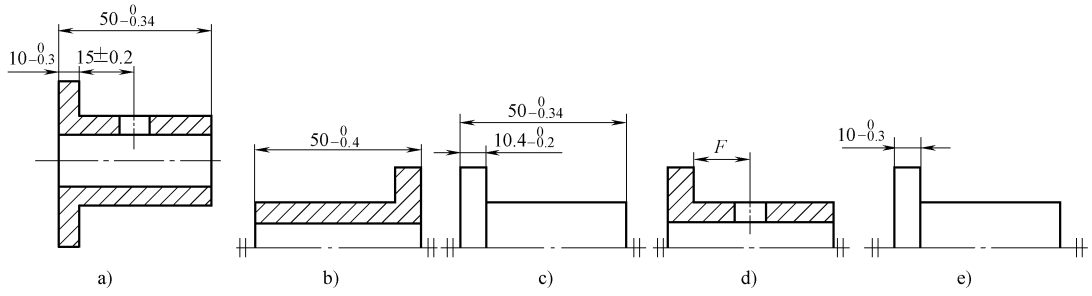
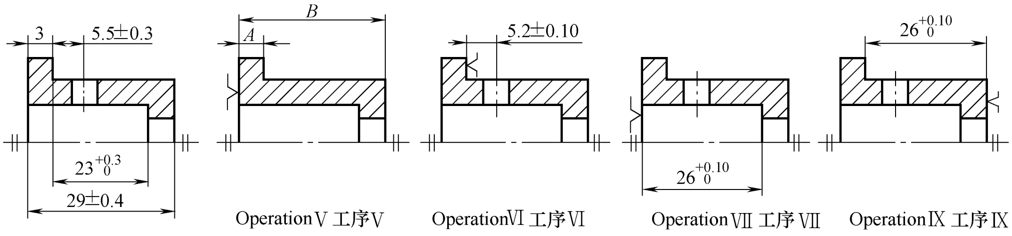


Fig. 3-22 Machining sequence of a sleeve 套筒零件的加工顺序

a) part drawing 零件图 b) turning the hole and facing 车孔和端面 c) cylindrical turning and facing 车外圆和端面 d) drilling 钻孔 e) grinding 磨台肩

25. Fig. 3-23 shows a sleeve-type workpiece in which only the relevant axial dimensions are labeled. Part of operations of its technological process is shown in Fig. 3-23b: finish turning the cylindrical surface in smaller diameter, facing and shoulder turning in operation Ⅴ; drilling the hole in operation Ⅵ; heat treatment in operation Ⅶ; grinding the hole and its inner end face in operation Ⅷ; grinding the cylindrical surface and its shoulder surface in operation Ⅸ. Try to find the operation dimensions A, B and their limit deviations.

图 3-23a 所示为一套类零件（图中只标注了有关的轴向尺寸）。其工艺过程的部分工序如图 3-23b 所示：工序Ⅴ，精车小端外圆、端面及台肩；工序Ⅵ，钻孔；工序Ⅶ，热处理；工序Ⅷ，磨孔及底面；工序Ⅸ，磨小端外圆及肩面。试求工序尺寸 A、B 及其极限偏差。



a) b)

Fig. 3-23 Sleeve-type workpart 套类零件

26. The machining route of a workpiece is shown in Fig. 3-24: rough turning the cylindrical surface in smaller diameter and shoulder, facing in operation Ⅰ; turning the cylindrical surface in larger diameter and facing in operation Ⅱ; finish turning the cylindrical surface in smaller diameter and shoulder, facing in operation Ⅲ.

Try to check whether the machining allowance in finish turning the smaller-diameter cylindrical surface is proper. If there is not enough machining allowance, how do you want to improve it?

某零件的加工路线如图 3-24 所示：工序Ⅰ，粗车小端外圆、轴肩及端面；工序Ⅱ，车大端外圆及端面；工序Ⅲ，精车小端外圆、轴肩及端面。

试校核工序Ⅲ精车小端外圆的余量是否合适？若余量不够应如何改进？

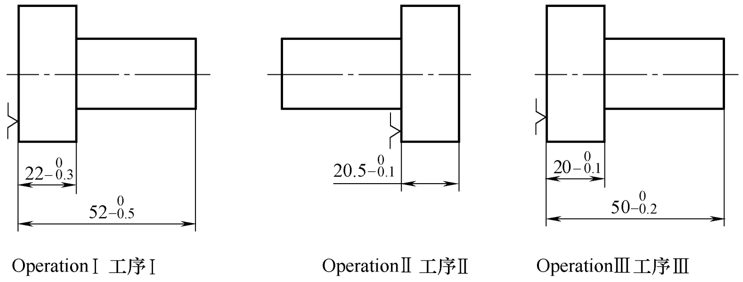


Fig. 3-24 Machining route of a step shaft 台肩轴的加工路线

27. A workpiece is shown in Fig. 3-25a. Parts of machining operations are shown in Fig. 3-25b, c and d. Try to check whether the operation dimensions and their limit deviations indicated on the operation drawing are correct? If not, how to correct them?

图 3-25a 所示为某零件简图，其部分加工工序如图 3-25b、c、d 所示。试校核工序图上所标注的工序尺寸及极限偏差是否正确？如不正确应如何改正？

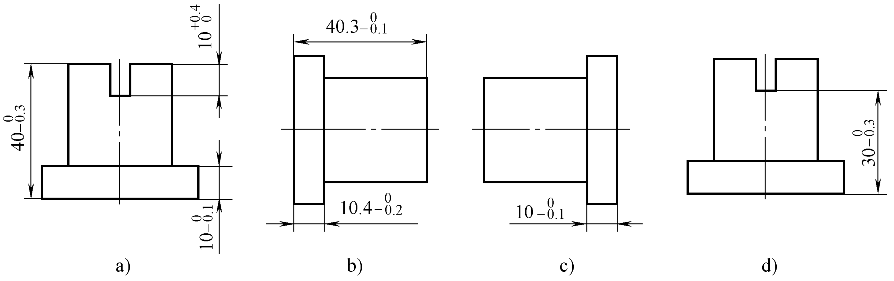


Fig. 3-25 Machining operations of a step shaft 台肩轴的加工工序

28. A fillister on a shaft shown in Fig. 3-26 is to be machined by means of adjusting method. If the left end face is used as the axial location datum in milling the fillister, try to dimension the operation dimension and its limit deviations.

采用调整法加工图 3-26 所示轴上的槽面。试标注以左端面轴向定位时的铣槽工序尺寸及其极限偏差。

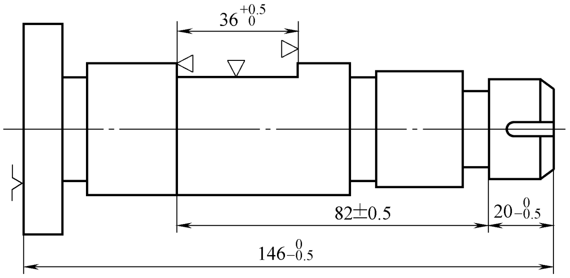


Fig. 3-26 Shaft 轴（1）

29. A workpiece made of medium carbon steel, as shown in Fig. 3-27 is to be machined. Please choose the proper process methods, tools and fixtures to machine the part, and arrange the process route for it.

欲加工图 3-27 所示的零件，其材料为中碳钢。试选择合适的工艺方法、刀具和夹具加工该零件，并安排其工艺路线。

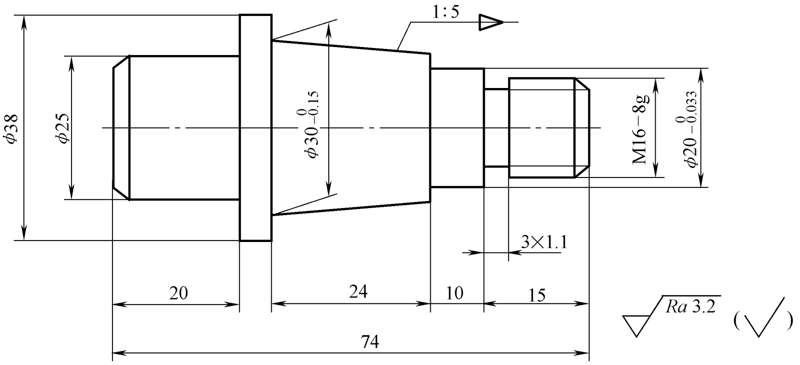


Fig. 3-27　Shaft 轴（2）

30. A batch of workpieces (without holes in the casting blank) made of grey cast iron, as shown in Fig. 3-28, are to be machine D. Try to make out the machining process route for it, and fill the relative process contents into Table 3-1.

欲加工图 3-28 所示的一批材料为灰铸铁的零件（铸件上没有孔）。试制订其加工工艺，并把相关工艺内容填入表 3-1 中。

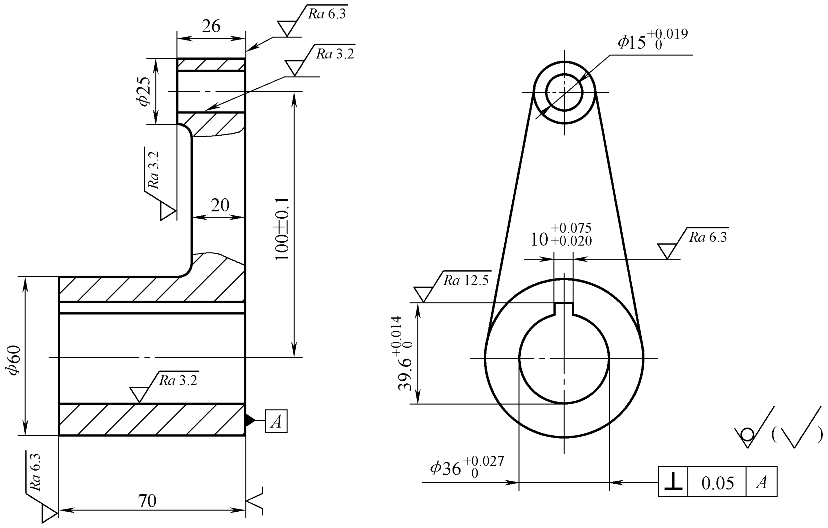


Fig. 3-28　Connection rod 连杆

Table 3-1　Process route of connection rod 连杆工艺规程

Operation No. 工序号	Operation name and contents 工序名称和内容	Location datum 定位基准	Machine tool 机床	Fixture 夹具

31. A batch of workpieces (30 pieces) made of HT200, as shown in Fig. 3-29, are to be machined. Try to prepare its process route, and fill relative process contents into Table 3-2. The blanks are precise casting.

欲加工图 3-29 所示的一批零件（30 件）。试编制其工艺规程，并将有关内容填入表 3-2 中。毛坯为精铸件。

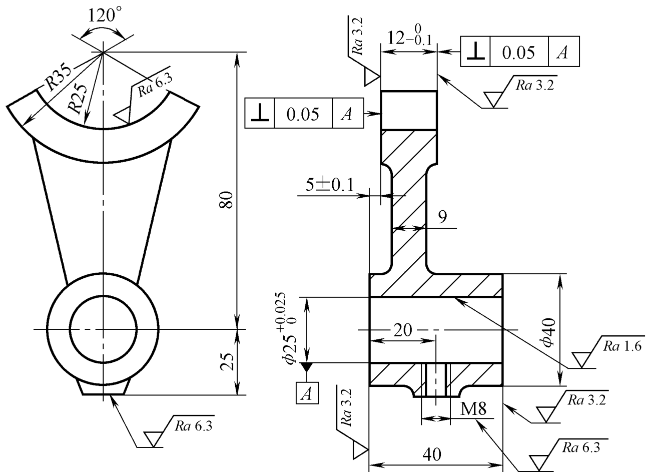


Fig. 3-29　Sliding fork 拨叉

Table 3-2　Process route of sliding fork 拨叉工艺规程

Operation No. 工序号	Operation name and contents 工序名称和内容	Location datum 定位基准	Machine tool 机床	Fixture 夹具

Chapter 4

Design Principles of Machine Tool Fixture

第4章

机床夹具设计原理

4.1 English-Chinese Terms 名词英汉对照

1. machine tool fixture 机床夹具
2. special-purpose fixture 专用夹具
3. location 定位
4. complete location 完全定位
5. incomplete location 不完全定位
6. insufficient location 欠定位
7. redundant location 过定位
8. location error 定位误差
9. datum displacement error 基准位移误差
10. basic support 基本支承
11. six-point locating principle 六点定位原理
12. auxiliary support 辅助支承

4.2 Filling in the blanks 填空题

1. The basic requirements for the locators on the fixture are____________________, ____________________, ____________________and____________________.

对于夹具上定位元件的基本要求是________、________、________和________。

2. The reasons for producing location error are _______________ and _______________.

造成定位误差的原因有_______________和_______________。

3. The location error caused by non-superposing of the location datum to the operation datum is called__________________error. The location error caused by the manufacturing error of location pairs is called____________________error.

定位基准与工序基准不一致引起的定位误差称为____________误差。由定位副制造不准确引起的定位误差称为________________误差。

4. The common used three clamping mechanisms are____________________, ________________and__________________, in which the mechanism with the best force-magnifying characteristic is__________________, the mechanism with the fastest action is__________________.

常用的三种夹紧机构是__________、____________和________。其中增力特性最好的是________________机构，动作最快的是______________机构。

5. A floating support can restrict____degree (s) of freedom; a long V-block can restrict____degree (s) of freedom.

一个浮动支承可以限制____个自由度，一个长的 V 形块可限制______个自由度。

6. Auxiliary support can restrict____degree (s) of freedom; the location form in which a degree of freedom is restricted by two or more locators is called____location.

辅助支承可以限制____个自由度；由两个定位元件限制同一自由度的定位称为____

定位。

7. The direction of clamping force should be ________________ the cutting force; The acting point of clamping force should be ________________ the surface to be machined as far as possible.

夹紧力的方向应与切削力方向______；夹紧力的作用点应尽可能______工件加工部位。

8. The structural forms of drilling jigs are _____________, _______________, ___________, ________________ and ___________________.

钻模的结构形式有__________、__________、__________、________和________。

9. The special element of drilling jigs is ______________________.

钻床夹具的特殊零件是________________。

10. Three standard structures of drilling bush is ____________, ____________ and ________.

钻套的三种标准结构是______________、________________和________________。

11. The special elements of milling machine fixture are ______________ and ______________.

铣床夹具的特殊零件是____________________和________________。

12. The drawing scale of the fixture assembly drawing should be in the scale of ______ as far as possible, The workpiece is drawn in ______________ line.

夹具装配图绘制尽量采用______的比例。工件用________线绘制。

4.3 Making choice 选择题

1. When milling a through slot on a plate, other degrees of freedom have been restricted except one degree of freedom along the length of slot. The location pattern belongs to ____.

A. complete location B. incomplete location

C. lack of location. D. redundant location

在一平板上铣通槽，除沿槽长方向的一个自由度未被限制外，其余自由度均被限制。此定位方式属于____。

A. 完全定位 B. 不完全定位 C. 欠定位 D. 过定位

2. The fixture which is used for both locating and clamping the workpiece and transporting the workpiece along the transfer line is called ____.

A. general-purpose fixture B. adaptable fixture

C. follow-fixture D. modular fixture

既要完成在其上定位并夹紧，还承担沿自动线输送工件的任务的夹具是____。

A. 通用夹具 B. 专用可调夹具 C. 随行夹具 D. 组合夹具

3. Two support plates arranged on the same plane are equivalent to ____ supporting points.

A. 2 B. 3 C. 4 D. innumerable

布置在同一平面上的两个支承板相当于____支承点。

A. 2个 B. 3个 C. 4个 D. 无数个

4. A short tapper pin fitting with a cylindrical borecan restrict ____ degree（s）of freedom.

A. 0 B. 1 C. 2 D. 3

一个可沿其轴线方向伸缩的短锥销与一个孔配合可限制____。

A. 0个自由度　　B. 1个自由度

C. 2个自由度　　D. 3个自由度

5. A movable short V-block can restrict ____ degree (s) of freedom of a workpiece.

A. 0　　B. 1　　C. 2　　D. 3

活动短V形块限制工件的自由度数为____。

A. 0个　　B. 1个　　C. 2个　　D. 3个

6. If the number of degrees of freedom restricted actually in the location of a workpiece is less than that have to be restricted in light of machining requirement, the location pattern is called ____.

A. complete location　　B. incomplete location

C. lack of location.　　D. redundant location

工件实际定位所限制的自由度数少于按其加工要求所必须限制的自由度数称为____。

A. 完全定位　　B. 部分定位　　C. 欠定位　　D. 过定位

7. When the external force is given, ____ can be used to increase the clamping force generated by the wedge.

A. increasing the wedge angle　　B. decreasing the wedge angle

C. zero wedge angle　　D. constant wedge angle

在外作用力一定时，欲增大斜楔产生的夹紧力，可____。

A. 增大楔角　　B. 减小楔角

C. 采用零楔角　　D. 使楔角不变

8. The drilling bush mainly used for drilling holes in small volume production is ____.

A. stationary drilling bush　　B. renewable drilling bush

C. rapid-replacing drilling bush　　D. special drilling bush

主要适合于小批生产时用钻头钻孔的钻套是____。

A. 固定钻套　　B. 可换钻套　　C. 快换钻套　　D. 特殊钻套

9. In cylindrical turning, two centers used for combination location are equivalent to ____ supporting points.

A. 3　　B. 4　　C. 5　　D. 6

在车床上加工外圆，使用两顶尖组合定位，相当于____支承点。

A. 3个　　B. 4个　　C. 5个　　D. 6个

10. In order to make the drawing view more intuitionistic, it is better to use the scale of ____ in the general drawing of fixture.

A. 1∶1　　B. 1∶2　　C. 2∶1　　D. 1∶5

为增强视图的直观性，夹具总图的比例最好用____。

A. 1∶1　　B. 1∶2　　C. 2∶1　　D. 1∶5

11. ____ is often used to drill the small hole on the large-size workpiece.

A. Stationary jig　　B. Rotary jig

C. Cover-type jig　　D. Overturn-type jig

在大型零件上加工小孔时，常使用____。

A. 固定式钻模　　B. 回转式钻模
C. 盖板式钻模　　D. 翻转式钻模

12. The finish datum which is often used for machining box-type workpiece in large volume production is ____ .

A. three planes　　B. two bearing holes
C. two planes and one hole　　D. one plane and two holes

大批量生产箱体零件常采用典型的精基准是____。

A. 三个平面　B. 两个轴承孔　C. 两面一孔　D. 一面两孔

13. When a workpiece is located on the longer taper mandrel by taking its taper hole as location datum, ____ degrees of freedom can be restricted.

A. 3　B. 4　C. 5　D. 6

工件以圆锥孔在较长圆锥心轴上定位，可限制____个自由度。

A. 3　B. 4　C. 5　D. 6

14. The connection type between the spindle and the fixture which turns together with the spindle depends on ____ .

A. the structural dimension of the fixture
B. the spindle nose structure of machine tool
C. the structural form of connection part on the fixture
D. the RPM of machine tool's spindle

随机床主轴一起转动的夹具与主轴的连接方式取决于____。

A. 夹具结构尺寸　　B. 机床主轴端部的结构形式
C、夹具连接部的结构形式　　D. 机床主轴的转速

15. If the drilling jig is used, the hole diameter to be machined is determined by ____ .

A. drilling bush　B. jig plate　C. drill　D. lining bush

使用钻床夹具时，决定被加工孔直径的是____。

A. 钻套　B. 钻模板　C. 钻头　D. 衬套

16. Before machining, the process to have the workpiece occupy a correct position on the machine tool or fixture is called ____ .

A. location　B. clamping　C. indexing　D. installation

在加工前，使工件在机床或夹具上占据一正确位置的过程称为____ .

A. 定位　B. 夹紧　C. 分度　D. 安装

17. The one that is used to determine the position of the fixture relative to the cutting tool on the fixture is ____.

A. location device　　B. clamping device
C. tool aligning-guiding device　　D. connection device

在夹具上确定夹具和刀具相对位置的是____。

A. 定位装置　　B. 夹紧装置
C. 对刀-导向装置　　D. 连接装置

18. The one used to determine the correct position of a workpiece in the fixture is ____.

A. locating element　　B. clamping element
C. tool aligning-guiding element　　D. connection element
用来确定工件在夹具中的正确位置的是____。
A. 定位元件　　B. 夹紧元件
C. 对刀-导向元件　　D. 连接元件

19. When the plane of a workpiece is used as location surface, the support without location role is ____.
A. stationary support　　B. adjustable support
C. self-alignment support　　D. auxiliary support
工件以平面定位时，不起定位作用的支承是____。
A. 固定支承　　B. 可调支承　　C. 浮动支承　　D. 辅助支承

20. Location error occurs chiefly when ____ is used to machine a batch of workpieces.
A. trial cutting method　　B. adjusting method
C. constant-size cutting tool　　D. tracing method
定位误差主要发生在按____加工一批工件的过程中。
A. 试切法　　B. 调整法
C. 定尺寸刀具法　　D. 轨迹法

21. The self-lock condition for wedge clamping mechanism is that the relation between the wedge angle α and the sum of two frictional angles should be ____.
A. $\alpha=\phi_1+\phi_2$　　B. $\alpha>\phi_1+\phi_2$　　C. $\alpha<\phi_1+\phi_2$　　D. $\alpha\geqslant\phi_1+\phi_2$
斜楔夹紧机构的自锁条件是楔角 α 与两处摩擦角之和 $\phi_1+\phi_2$ 应满足____。
A. $\alpha=\phi_1+\phi_2$　　B. $\alpha>\phi_1+\phi_2$　　C. $\alpha<\phi_1+\phi_2$　　D. $\alpha\geqslant\phi_1+\phi_2$

22. The powered clamping device on modular machine tools are often ____ .
A. manual clamping　　B. pneumatic clamping
C. hydraulic clamping　　D. electric clamping
在组合机床上的机动夹紧装置多采用____。
A. 手动夹紧　　B. 气动夹紧　　C. 液压夹紧　　D. 电动夹紧

23. The fixture which is installed on the spindle of machine tool and rotates the workpiece with it is called ____.
A. drilling jig　　B. lathe fixture
C. fixture of milling machine　　D. boring jig
安装在机床主轴上，能带动工件一起旋转的夹具是____。
A. 钻床夹具　　B. 车床夹具　　C. 铣床夹具　　D. 镗床夹具

24. When drilling hole on a drilling jig, the hole dimension accuracy relies mainly on ____ .
A. machine tool precision
B. drilling bush precision
C. positional accuracy of drilling bush on jig plate
D. cutting tool precision
在钻模上加工孔时，孔的尺寸精度主要取决于____。

A. 机床精度 B. 钻套精度
C. 钻套在钻模板上的位置精度 D. 刀具精度

25. It is better using ____ to drill the holes distributed on the different surfaces of small-size workpieces.

A. a stationary jig B. a rotary jig
C. an overturn-type jig D. a cover-type jig

加工小型工件上分布在不同表面上的孔宜采用____。

A. 固定式钻模 B. 回转式钻模 C. 翻转式钻模 D. 盖板式钻模

26. When drilling a group of holes on the same surface of a batch of small and medium sized workpieces, given that the distance error between holes is larger than ±0.15mm, preferred type of drilling jig is ____ .

A. fixed type B. movable type C. cover-type D. sliding pillar-type

加工一批中小型工件上位于同一表面上的一组孔，孔距误差大于±0.15mm，则优先选用的钻模类型为____。

A. 固定式 B. 移动式 C. 盖板式 D. 滑桩式

27. In drilling, using the ____ drilling jig can make the holes obtain higher positional accuracy.

A. fixed type B. hinged type
C. demountable type D. hanged type

在加工孔时，可以获得较高位置精度的钻模板形式是____。

A. 固定式 B. 链接式 C. 分离式 D. 悬挂式

28. In commonly used clamping mechanisms, the one with the largest force magnification coefficient is ____.

A. wedge clamping mechanism B. screw clamping mechanism
C. eccentric clamping mechanism D. collect clamping head

在常用的典型夹紧机构中，扩力比最大的是____。

A. 斜楔夹紧机构 B. 螺旋夹紧机构
C. 偏心夹紧机构 D. 弹簧夹头

29. A degree of freedom is repeatedly restricted by two or more locators. This kind of location belongs to ____ .

A. complete location B. incomplete location
C. lack of location D. redundant location

由两个或两个以上定位点重复约束了同一个自由度，此种定位方式属于____。

A. 完全定位 B. 不完全定位 C. 欠定位 D. 过定位

30. When the cylindrical surface of the workpiece is positioned on a short V-block, ____ degrees of freedom are restricted.

A. 2 B. 3 C. 4 D. 5

工件以外圆在短 V 形块上定位时，约束工件的自由度为____。

A. 2 个 B. 3 个 C. 4 个 D. 5 个

31. When grinding the plane of workpiece on the surface grinding machine, ____ degree(s) of freedom should be restricted at least.

A. 1　　B. 2　　C. 3　　D. 4

工件在平面磨床上磨平面时，至少应约束____个自由度。

A. 1 个　　B. 2 个　　C. 3 个　　D. 4 个

32. When drilling the small holes on a large-size workpleces, ____ drilling jig should be used.

A. fixed type　　B. overturn-type　　C. rotary　　D. cover-type

在大型零件上钻小孔时，应采用的钻模形式为____。

A. 固定式　　B. 翻转式　　C. 回转式　　D. 盖板式

33. When drilling the holes in small volume production, ____ drilling bush is commonly used.

A. fixed type　　B. renewable

C. rapid-replacing　　D. special

小批量生产钻孔时常采用的钻套形式是____。

A. 固定式　　B. 可换式　　C. 快换式　　D. 特殊钻套

34. The drilling bush primarily used for drilling holes in large volume production is ____.

A. fixed type　　B. renewable

C. rapid-replacing　　D. special

主要用于大批量生产中钻孔的钻套是____。

A. 固定式钻套　　B. 可换钻套　　C. 快换钻套　　D. 特殊钻套

35. Generally speaking, the drilling jig structure with higher drilling accuracy is ____ .

A. fixed type　　B. overturn-type　　C. rotary　　D. sliding pillar-type

一般来说，钻孔精度较高的钻模结构形式是____。

A. 固定式　　B. 翻转式　　C. 回转式　　D. 滑柱式

36. It is allowed to use the rough datum ____ in the same dimensional direction.

A. 1 time　　B. 2 times　　C. 3 times　　D. any time

粗基准在同一尺寸方向上允许使用____。

A. 一次　　B. 二次　　C. 三次　　D. 任意次

37. ____ belongs to the location error.

A. Random error　　B. Adjustable error

C. Clamping error　　D. Datum non-superposing error

____属于定位误差 .

A. 随机误差　　B. 调整误差

C. 夹紧误差　　D. 基准不重合误差

38. When milling a plane on a cylinder, two fixed short V-blocks are used to locate the cylinder, which restricts ____ degrees of freedom.

A. 2　　B. 3　　C. 4　　D. 5

在外圆柱上铣平面，用两个固定短 V 形块定位，其限制了工件的自由度数为____。

A. 2 个　　B. 3 个　　C. 4 个　　D. 5 个

39. When drawing the workpiece contour on the fixture drawing, ____ should be used.

A. dot dash line B. dotted line
C. double dot dash line D. fine line
在夹具图上画工件轮廓时，应采用____。
A. 点画线 B. 虚线 C. 双点画线 D. 细实线

4.4 True or false 判断题

1. In the workpiece location plan, incomplete location is not permitted. ( )
不完全定位在工件的定位方案中是不允许出现的。( )
2. Lack of location is not permitted. ( )
欠定位是不允许的。( )
3. Generally, the adjustable support have to be adjusted once per each workpiece, whereas the auxiliary support can only be adjusted once per batch. ( )
可调支承一般加工每件都要调整一次，而辅助支承可以加工每批调整一次。( )
4. Using 6 support tacks for location means restricting 6 degrees of freedom. ( )
采用六个支承钉定位，则限制了六个自由度。( )
5. Redundant location means that the number of degrees of freedom restricted actually is more than that of degrees of freedom which must be restricted. ( )
过定位是指工件实际被限制的自由度数多于工件加工所必须限制的自由度数。( )
6. If the number of locating points is not more than 6, redundant location would not occur. ( )
定位支承点不超过六个，就不会出现过定位。( )
7. Once a workpiece is clamped tightly, it can be said that the workpiece is located completely. ( )
一旦某工件被牢牢地夹紧了，就说该工件已完全定位了。( )
8. The location pattern less than six locators is the incomplete location. ( )
少于六个定位支承点的定位方式就是不完全定位。( )
9. The floating support with three points contaction with the workpiece is able to restrict one degree of freedom only. ( )
一个三点浮动支承只能约束一个自由度。( )
10. Of the common used clamping mechanisms, the screw clamping mechanism has the best self-locking performance. ( )
在常用的夹紧机构中，螺旋夹紧机构的自锁性最好。( )
11. The eccentric clamping device can't be used in the situation with large cutting force and vibration. ( )
偏心夹紧装置不能用于切削力大和有振动的场合。( )
12. The special element of drilling jig is the location key. ( )
钻床夹具的特殊元件是定位键。( )

4.5 Short-answer questions 简答题

1. What are the functions of fixtures? What are the main components of fixtures?
夹具的功用有哪些？夹具由哪些主要部分组成？

2. Based on the application range of fixtures, how to classify the machine tool's fixtures?
按照夹具的应用范围，机床夹具如何分类？

3. What are the commonly used location elements when a workpiece is located by its plane? Try to analyze the case in eliminating the degree of freedom.
工件以平面定位，常用的定位元件有哪些？并分析消除自由度情况。

4. What are the commonly used location elements when a workpiece is located by its cylindrical hole. Try to analyze the case in eliminating the degree of freedom ( ).
工件以圆柱孔定位，常用的定位元件有哪些？并分析消除自由度情况。

5. What are the commonly used location elements when a workpiece is located by its external cylindrical surface. Try to analyze the case in eliminating the degree of freedom. ( )
工件以外圆表面定位，常用定位元件有哪些？并分析消除自由度情况。( )

6. What are the main components of clamping device? ( )
夹紧装置由哪些主要部分组成？( )

7. What are the basic requirements for the design of workpiece clamping device? ( )
对工件夹紧装置设计的基本要求有哪些？( )

8. State briefly the general principle of choosing the direction of clamping force. ( )
简述选择夹紧力方向的一般原则。( )

9. State briefly the general principle of choosing the acting point of clamping force. ( )

简述选择夹紧力作用点的一般原则。(   )

10. What is the essential difference between incomplete location and insufficient location? (   )

不完全定位和欠定位的本质区别是什么?(   )

11. What kinds of fixtures are often used in lathe operations? What attention items should be paid in design lathe fixtures?

在车床操作中常使用的夹具有哪几种类型? 在设计车床夹具时应注意哪些问题?

12. What methods are used to connect the fixture to the lathe spindle? What are their characteristics?

车床夹具与车床主轴的连接方式有哪几种? 各有何特点?

13. What kinds of fixtures are often used in drilling operations? What situations are they applied to? What is the special element of drilling machine fixture?

在钻削工序中,常使用的夹具有哪几种类型? 它们各适用于何种场合? 钻床夹具的特殊元件是什么?

14. In several jig structures, which one has the best working accuracy?

在几种钻模结构中,哪种工作精度最高?

15. What are the special elements of milling machine fixtures? What attention items should be paid in design milling machine fixtures?

铣床夹具的特殊元件是什么? 在设计铣床夹具时应注意哪些问题?

16. Illustrate what poor results may be caused by redundant location. How to treat redundant location if there is.

举例说明过定位可能产生哪些不良后果。如何处理出现的过定位?

17. What are the differences between auxiliary support and self-alignment support?

辅助支承与自位支承有何不同?

18. Try to explain the reasons for location error.

试述产生定位误差的原因。

4.6 Analysis and calculation 分析与计算题

1. Try to analyze whether each location plan is rational or not based on the location plans shown in Fig. 4-1 to Fig. 4-4. If it is irrational, please propose a way to modify it.

根据图 4-1~图 4-4 所示定位方案，试分析该定位方案的合理性。如果不合理，请提出改进方案。

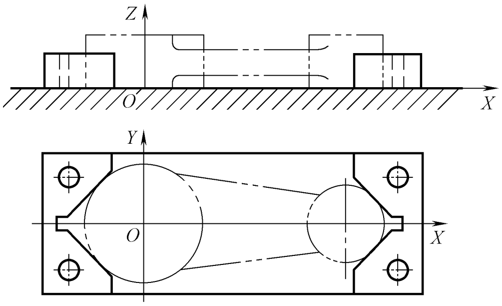


Fig. 4-1 A linkage 连杆

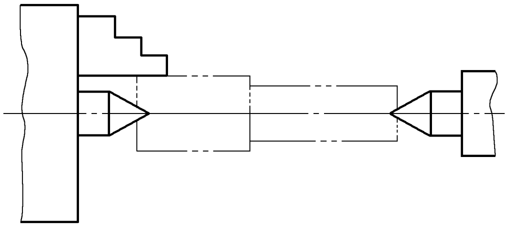


Fig. 4-2 A shaft 轴

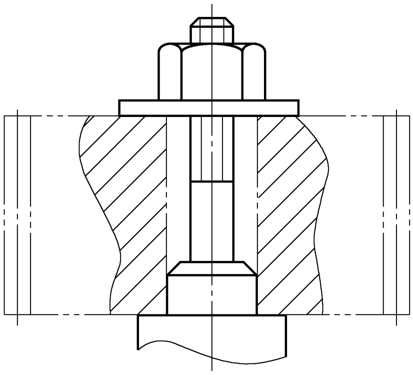


Fig. 4-3 A gear 齿轮

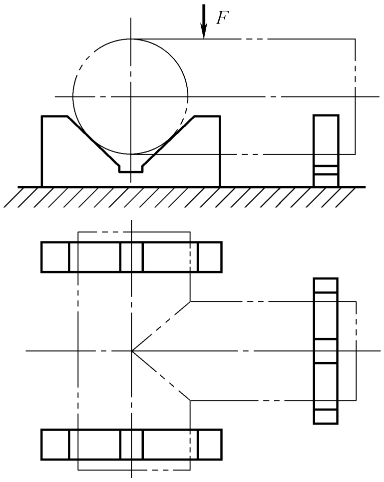
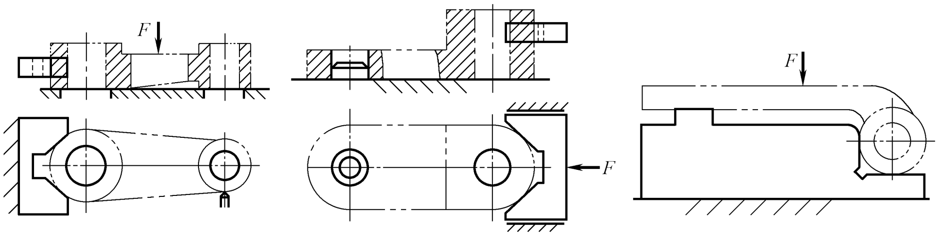


Fig. 4-4 A T-shart T 形轴

2. Based on the principle of determining clamping force, try to analyze the clamping plan shown in Fig. 4-5, point out the inadequacies and improve them.

根据夹紧力的确定原则，分析图 4-5 所示夹紧方案，指出不妥之处并加以改正。



a) b) c)

Fig. 4-5 Workpiece clampirg plan 零件夹紧方案

3. Based on the six-point location principle to analyze the each location plan in Fig. 4-6, and point out the degrees of freedom restricted by each location element.

根据六点定位原理，分析图 4-6 所示各定位方案中各定位元件所消除的自由度。

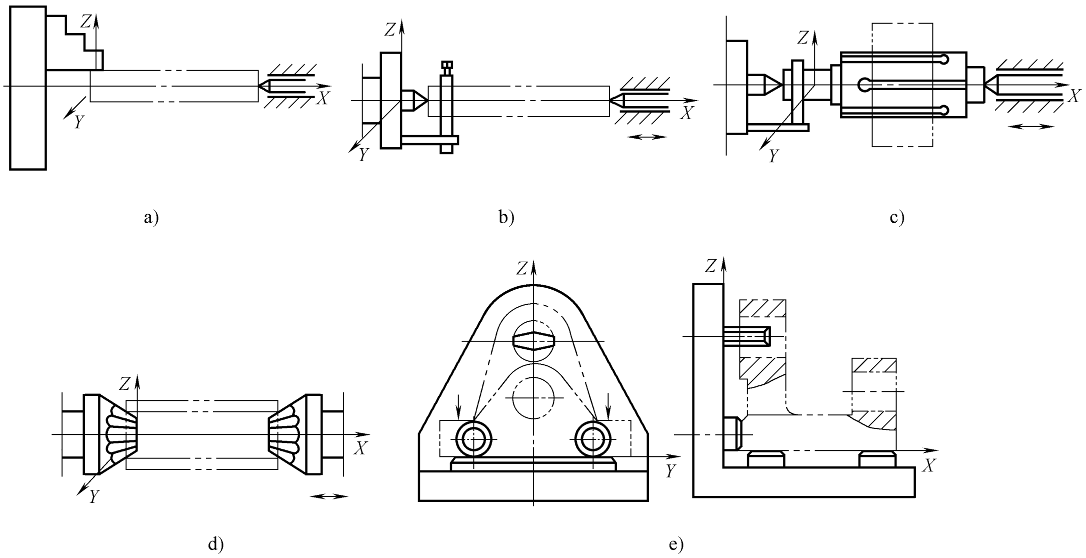


Fig. 4-6　Various location plan 各种定位方案

4. Based on the location situations shown in Fig. 4-7, point out which degrees of freedom are restricted by each location element. What kind of location pattern is it? If the location plan is irrational, how to improve it?

根据图 4-7 所示定位情况，指出图中各定位元件限制哪几个自由度。属于何种定位？如果不合理，应如何改进？

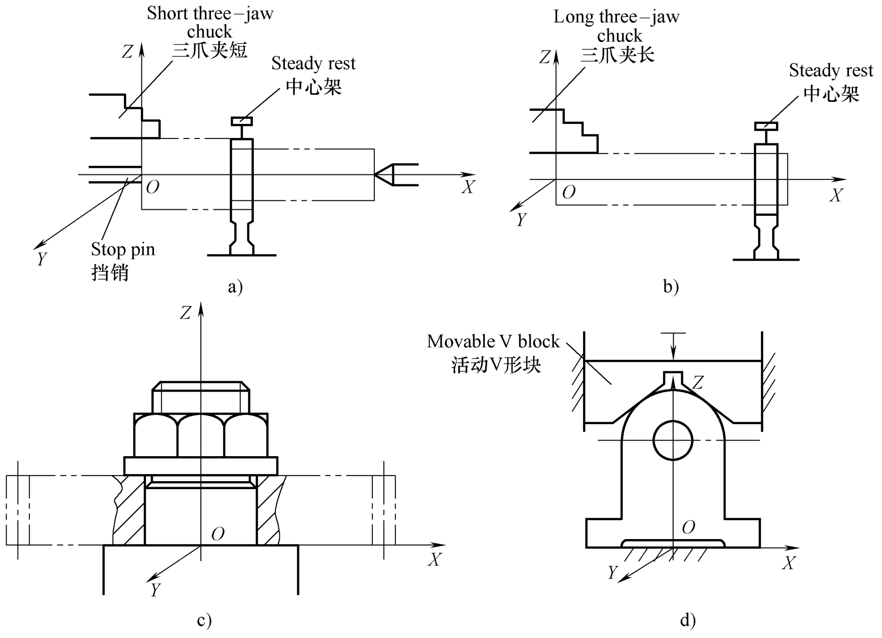


Fig. 4-7　Analysis of the degree of freedom analysis (1) 自由度分析 (1)

5. Try to analyze the freedom degrees which have to be constrained when the workpiece shown in Fig. 4-8a to d respectively is machined.

a) The blind hole ϕB is to be drilled, and the dimension H must be ensured.

b) The hole ϕB is to be drilled. It's required that ϕB should be perpendicular to ϕD, and the dimension L must also be ensured.

c) A slot is to be cut. It's required to ensure the slot width B, and the dimensions H and L must be ensured.

d) A slot is to be cut. It's required to ensure the slot width B, depth H, and the relative position of slot to 4-hole.

试分析图 4-8 所示各零件加工所必须限制的自由度。

a) 在球上钻不通孔 ϕB，保证尺寸 H。

b) 在套筒零件上加工 ϕB 孔，要求与 ϕD 孔垂直相交，且保证尺寸 L。

c) 在轴上铣横槽，保证槽宽 B 以及尺寸 H 和 L。

d) 在支座零件上铣槽，保证槽宽 B 和槽深 H 及与四个均布孔的位置度。

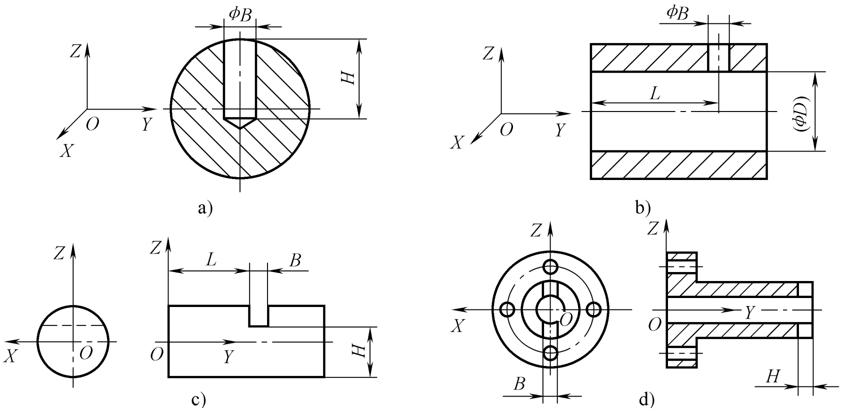


Fig. 4-8 Analysis of the degree of freedom analysis (2) 自由度分析 (2)

6. A sleeve-type workpiece is shown in Fig. 4-9a. The location plans shown in Fig. 4-9b and c are used respectively to cut a slot. It is required to ensure the dimension $94_{-0.20}^{0}$mm. Try to calculate the location error of each location plan respectively.

图 4-9a 所示套类工件，分别采用图 4-9b、c 所示的定位方案铣键槽，要求保证尺寸 $94_{-0.20}^{0}$mm。分别计算定位误差。

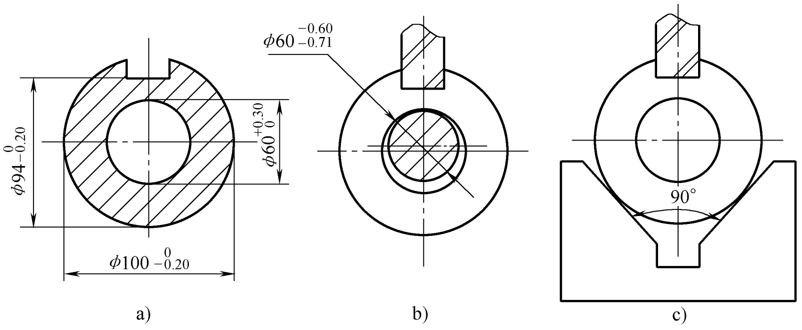


Fig. 4-9 Location plans for cutting a slot 铣键槽定位方案

7. The workpiece location form is shown in Fig. 4-10. Surface C is to be machined to ensure (20±0.1)mm. Can the location plan meet the requirement for the workpiece? If it can't, how to modify the location plan?

工件的定位形式如图 4-10 所示。加工平面 C，保证尺寸（20±0.1)mm。此定位方案能满足工件的加工要求吗？如果不能，如何改进定位方案？

8. As shown in Fig. 4-11, the workpiece is located by surface A and surface B to drill the hole of ϕ10H7, try to calculate the location error for (12±0.1)mm and (30±0.1)mm separately.

如图 4-11 所示，工件以平面 A 和 B 定位钻孔 ϕ10H7，试分别计算对（12±0.1)mm 和 (30±0.1)mm 的定位误差。

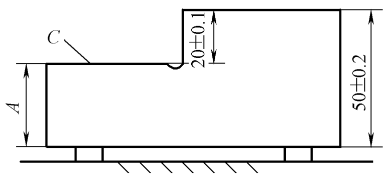


Fig. 4-10 To machine the surface C 加工平面 C

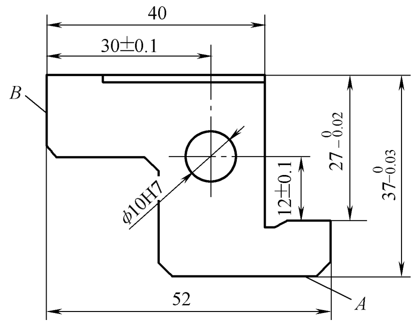


Fig. 4-11 Drilling 钻孔

9. A batch of workpieces shown in Fig. 4-12a are located by a V-block on jig to drill two holes with the diameter ϕ5mm and ϕ8mm. Besides ensuring the technical requirements indicated on the workpiece drawing, the symmetry tolerance (0.08mm) of connecting line between two hole centers to the axis of $\phi 60_{-0.1}^{\ 0}$ mm should also be ensured. There are three location plans to be used, as shown in Fig. 4-12b, c, and d ($\alpha=90°$). If the location error should not be larger than 1/2 of operational dimension tolerance, which location plan is feasible? And which one is the best?

有一批图 4-12a 所示的工件，采用钻模钻削工件上 ϕ5mm 和 ϕ8mm 两个孔，除保证图样要求外，还要求保证两孔连心线通过 $\phi 60_{-0.1}^{\ 0}$ mm 的轴线，其对称度公差为 0.08mm。现采用图 4-12b、c、d 所示三种定位方案（$\alpha=90°$）。若定位误差不得大于工序公差的 1/2，试问这三种定位方案是否都可行？

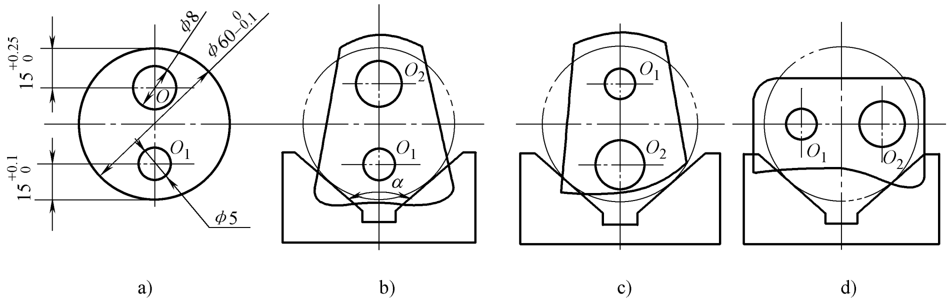


Fig. 4-12 Different location plans for drilling 钻孔定位方案

10. A batch of workpieces shown in Fig. 4-13 are located by a V-block to drill a hole O. Operation dimension A and its tolerance must be ensured. Try to calculate the location error of the location plan.

工件定位如图 4-13 所示，一批工件以 V 形块定位钻孔 O，要求保证尺寸 A。试分析计算此种定位方案的定位误差。

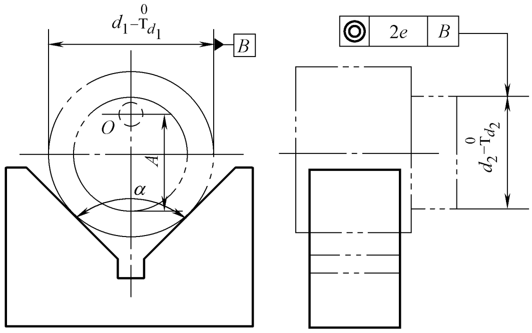


Fig. 4-13 V-block location for drilling
V 形块定位钻孔

11. A batch of workpieces is shown in Fig. 4-14a. It is determined to cut a gap by milling to ensure the dimension $8_{-0.08}^{0}$ mm. There are two location plans to be used as shown in Fig. 4-14b and c. Try to calculate the location error of two location plan respectively and analyze whether the location plan can meet the machining requirement. If not, please propose a modifying plan.

加工图 4-14a 所示的一批零件，在工件上欲铣削一缺口，保证尺寸 $8_{-0.08}^{0}$ mm。现采用图 4-14b、c 所示的两种定位方案，试计算各定位误差，并分析能否满足加工要求。如不能满足加工要求，请提出改进方案。

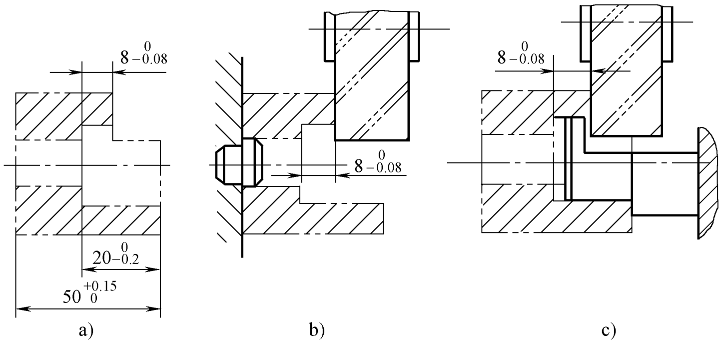


Fig. 4-14 Two location plans in cutting gap 铣缺口的两种定位方案

12. A batch of workpieces are shown in Fig. 4-15a. It is determined to cut a gap by milling to ensure the dimensions $10_{-0.08}^{0}$ mm and $8_{-0.02}^{0}$ mm. Given that the other dimensions have been achieved in the preceding operations. If the location scheme shown as Fig. 4-15b is adopted, and the

location hole is fit with location pin in H7/g6, please make sure if the machining accuracy can be ensured. If not, how to modify the location scheme?

如图 4-15a 所示，欲在工件上铣削一缺口，保证尺寸 $10_{-0.08}^{0}$mm 和 $8_{-0.12}^{0}$mm。已知其余表面在前几道工序均已加工好。如果采用图 4-15b 所示定位方案，且孔与销的配合为 H7/g6，试确定该定位方案能否保证加工要求。如果不能，应如何修改定位方案？

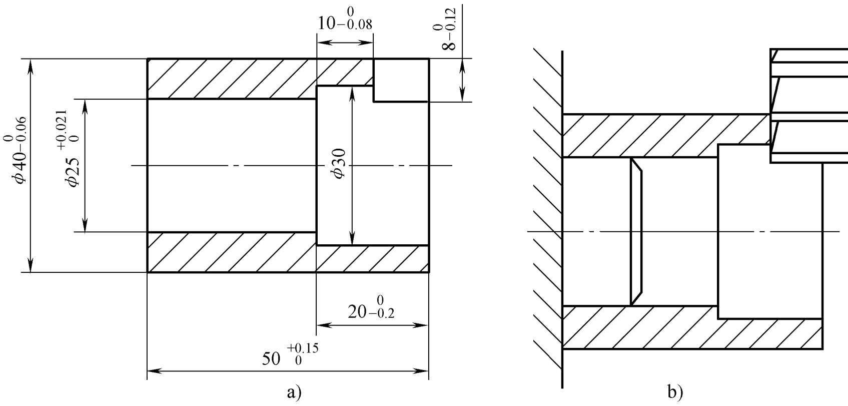


Fig. 4-15 Location plan for cutting gap 铣缺口的定位方案

13. A keyway of the workpiece shown in Fig. 4-16 is to be cut. The dimension $54_{-0.14}^{0}$mm and the symmetry tolerance 0.03mm should be ensured. There are three location schemes, as shown in Fig. 4-16b, c, d. Try to calculate the location error of each location scheme respectively, and choose the best location scheme.

在图 4-16 所示工件上加工键槽，要求保证尺寸 $54_{-0.14}^{0}$mm 和对称度公差 0.03mm。现有三种定位方案，分别如图 4-16b、c、d 所示。试分别计算三种方案的定位误差，并选择最佳方案。

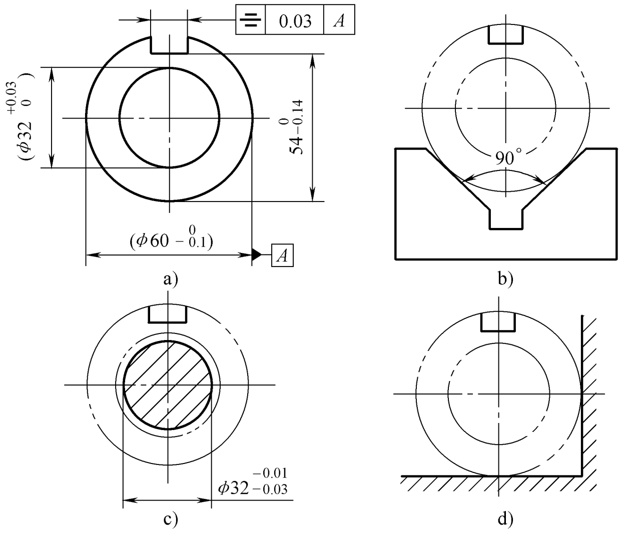


Fig. 4-16 Location plan for milling keyway
铣键槽的定位方案

14. Fig. 4-17 shows a gear blank. Given that its external cylindrical surface and hole have been machined to required size ($D=\phi35^{+0.025}_{0}$ mm, $d=\phi80^{0}_{-0.1}$ mm). Now it is determined to cut the slot on slotting machine by means of adjusting method, and $H=38.5^{+0.2}_{0}$ mm should be ensured. Try to calculate the location error of the location scheme shown in Fig. 4-17 (the coaxial error between external cylindrical surface and hole can be ignored).

图 4-17 所示齿轮坯的内孔及外圆已加工合格（$D=\phi35^{+0.025}_{0}$ mm，$d=\phi80^{0}_{-0.1}$ mm）。现在插床上以调整法加工键槽，要求保证尺寸 $H=38.5^{+0.2}_{0}$ mm。试计算图示定位方法的定位误差（忽略外圆与内孔的同轴度误差）。

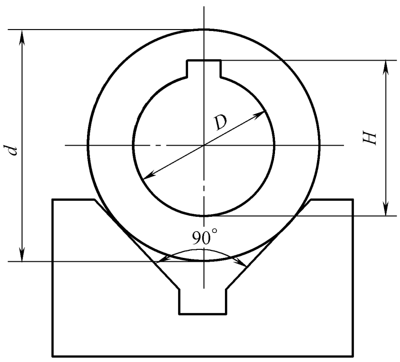


Fig. 4-17 Slotting 插键槽

15. The machining requirements for slot milling operation are shown in Fig. 4-18a. Given that the shaft diameter is $\phi80^{0}_{-0.1}$ mm, try to calculate the location error of each location scheme shown in Fig. 4-18 b, c respectively.

图 4-18a 所示为铣键槽工序的加工要求。已知轴径尺寸 $\phi80^{0}_{-0.1}$ mm，试分别计算图4-18 b、c 所示两种定位方案的定位误差。

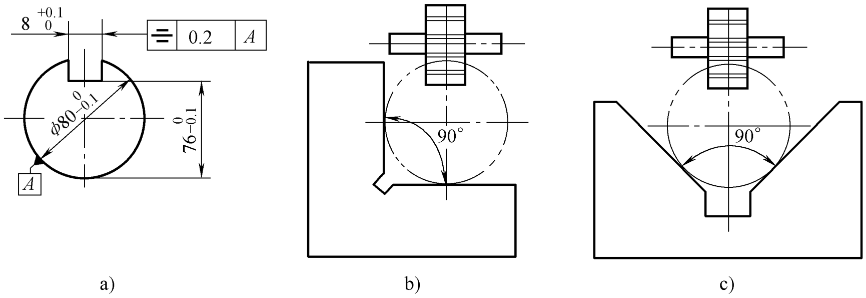


Fig. 4-18 Location error of two location schemes 两种定位方案的定位误差

16. A keyway in a batch of sleeve-type workpiece shown in Fig. 4-19a is to be cut. Try to calculate the location error of operation dimensions H_1, H_2, H_3 respectively in the following location schemes.

(1) The workpiece is located on the expandable mandrel (Fig. 4-19b).

(2) The workpiece is located on the horizontal mandrel (Fig. 4-19c) with clearance fit, and the diameter of the mandrel is $d_{\Delta_{xd}}^{\Delta_{sd}}$.

欲在图 4-19a 所示的一批套类零件上铣一键槽。试计算下列定位方案中，尺寸 H_1、H_2、H_3 的定位误差。

（1）零件在可胀心轴上定位（图 4-19b）。

（2）零件在处于水平放置的刚性心轴上具有间隙的定位（图 4-19c），定位心轴直径为 $d_{\Delta_{xd}}^{\Delta_{sd}}$。

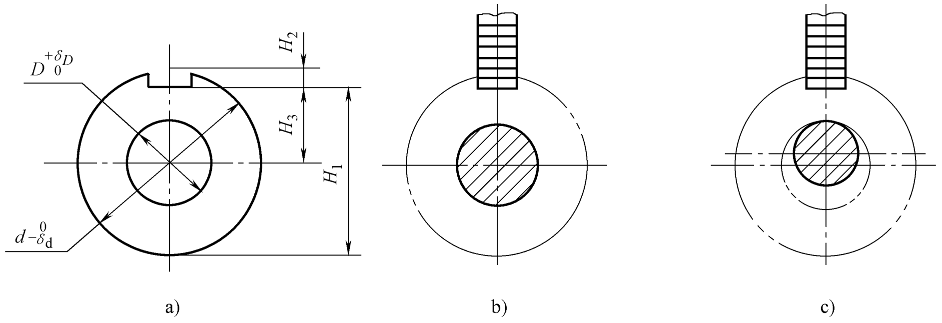


Fig. 4-19 Milling keyway in different location form 以不同的定位形式铣键槽

17. As shown in Fig. 4-20, the workpiece is located on a horizontal mandrel to cut two inclined surfaces, and the dimension $a \pm T_a/2$ should be ensured. Try to calculate its location error.

如图 4-20 所示，工件以圆孔在水平心轴上定位铣两个斜面，要求保证加工尺寸为 $a \pm T_a/2$，试计算定位误差。

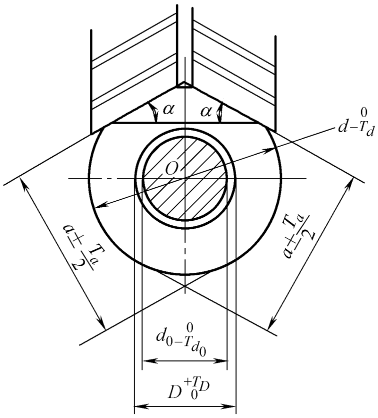


Fig. 4-20　Location error in milling angular surfaces
铣斜面的定位误差

18. A circular plate with a plane on is located on a special locator shown in Fig. 4-21 to machine the hole with $\phi\ 20^{+0.045}_{\ 0}$ mm in diameter. Given that the diameter $\phi\ 80^{\ 0}_{-0.15}$ mm and the dimension (30±0.07) mm have been ensured, try to calculate the symmetrical error between the hole and external cylindrical surface caused by this location manner.

圆盘形工件外径 $\phi 80^{\ 0}_{-0.15}$ mm，按尺寸（30±0.07）mm 铣出一平面，然后通过图 4-21 给出定位元件定位加工内孔 $\phi\ 20^{+0.045}_{\ 0}$ mm。试计算孔加工后由于定位所产生的与外圆的同轴度误差。

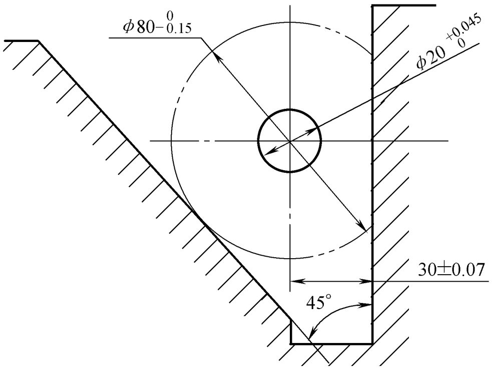


Fig. 4-21　Location plan for drilling
钻孔的定位方案

19. When machining a hole O_1, the location scheme of a workpiece is shown in Fig. 4-22. Try to analyze whether this location scheme can meet the requirements for the hole O_1; if this location is used, how to reduce the location error?

图 4-22 所示为某工件的定位方案。试分析加工孔 O_1 时，能否满足加工要求；若定位方案不变，如何减小定位误差？

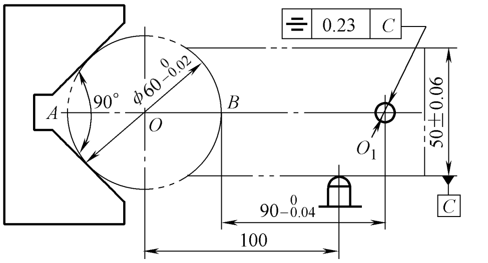


Fig. 4-22 Location scheme of a workpiece in drilling
工件钻孔时的定位方案

20. The location scheme used for machining an opening on a cylindrical workpiece is shown in Fig. 4-23. Try to analyze whether this location scheme can meet the requirements for the opening. If can't, try to propose the improving methods.

在圆柱工件上铣缺口的定位如图 4-23 所示。试分析该定位方案能否满足工序要求。若不能满足，试提出改进方法。

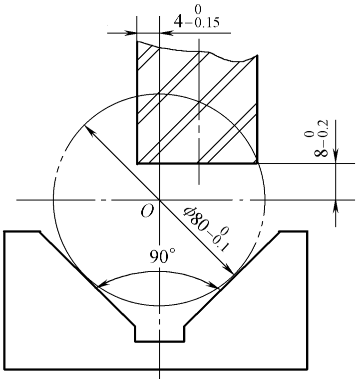


Fig. 4-23 Machining an opening on a cylindrical workpiece 在圆柱工件上铣缺口

21. The location schemes used for machining a slot on a cylindrical workpiece are shown in Fig. 4-24. It is required that the dimension m or the dimension n should be ensured. Try to calculate the location error of each location scheme shown in Fig. 4-24a, b, c respectively.

在圆柱工件上铣一键槽的定位方案如图 4-24 所示，要求保证尺寸 m 或 n。试分析计算图 4-24a、b、c 所示三种定位方案的定位误差。

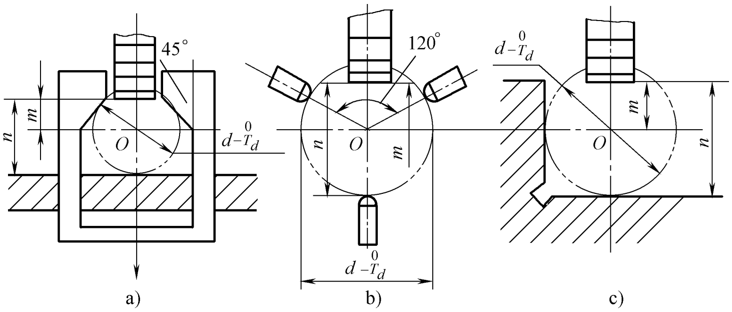


Fig. 4-24 Location schemes for milling a slot 铣键槽的定位方案

22. A batch of cylindrical workpieces are located on a V-block, as shown in Fig. 4-25. Given that the OD of the workpiece is $d_{-T_d}^{\ 0}$, the ID of the workpiece is $D_{\ 0}^{+T_D}$, and the concentricity of the external cylindrical surface with the hole is $2e$. A keyway ia to be cut in the operation, and the operation dimension A should be ensured. Try to analyze:

(1) How large is the maximum variation of A caused by the location scheme?

(2) What kind of location scheme should be taken so that the variation of A can be minimum?

一批圆柱形工件在 V 形块上定位铣键槽，如图 4-25 所示。已知：工件外径为 $d_{-T_d}^{\ 0}$，内孔直径为 $D_{\ 0}^{+T_D}$，外径与内孔的同轴度公差为 $2e$。本工序加工键槽，要求保证尺寸为 A。试分析计算：

(1) 该定位方案引起工序尺寸 A 的最大变化量是多少？

(2) 采取什么定位方案可使工序尺寸 A 的变化量最小？

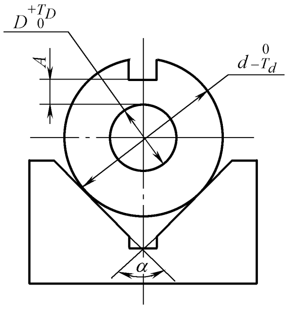


Fig. 4-25 Milling keyway on a cylindrical workpiece
在圆柱工件上铣键槽

23. A workpiece is shown in Fig. 4-26a. Given that other surfaces have been machined, the coaxality between the cylindrical surface with $\phi 40_{-0.03}^{\ 0}$mm and the cylindrical surface with $\phi 35_{-0.02}^{\ 0}$ mm is $\phi 0.02$mm. This operation is to drill the hole O, and ensures $30_{-0.11}^{\ 0}$mm, as shown in Fig. 4-26a. Try to calculate the location error of each location plan shown in Fig. 4-26b to i respectively (In machining, the axis of workpiece is in the horizontal status, the included angle of V-block $\alpha = 90°$).

图 4-26a 所示工件，已知其余表面均已加工好，$\phi 40_{-0.03}^{\ 0}$mm 外圆与 $\phi 35_{-0.02}^{\ 0}$mm 外圆的同轴度公差为 $\phi 0.02$mm。本道工序钻孔 O，要求保证尺寸 $30_{-0.11}^{\ 0}$mm。试计算图示各种定位方案的定位误差（加工时工件轴线处于水平位置，V 形块夹角 $\alpha = 90°$）。

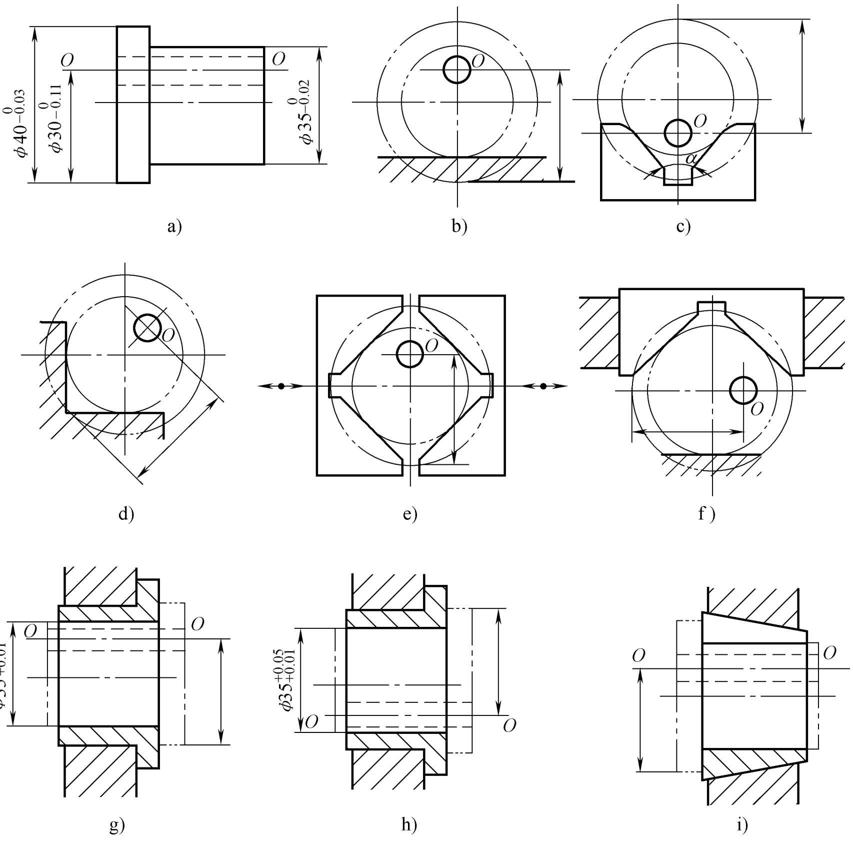


Fig. 4-26 Drilling holes in the different location plans 用不同的定位方案钻孔

24. As shown in Fig. 4-27, "one plane and two holes" of a workpiece are used to locate the workpiece, and two location pins are placed vertically. Two holes O_3 and O_4 in the workpiece are to be drilled, and the distance $50_{0}^{+0.5}$mm should be ensured. If it is required that the location error be 1/2 of operation tolerance only, try to design the location plan with "one plane and two holes": to determine the spacing tolerance between two pins (take $\delta_{\mathrm{ld}}=\frac{1}{4}\delta_{\mathrm{LD}}$), diameter of straight pin and its tolerance (taking f7), diameter of rhombus pin and its tolerance, and to determine by calculating location error whether the location plan can meet the positional accuracy requirements for O_3 and O_4 holes. If not, what measures should be taken?

如图 4-27 所示，工件采用一面两孔定位，两定位销垂直放置。现欲在工件上钻两孔 O_3 和 O_4，要保证尺寸 $50_{0}^{+0.5}$mm。若定位误差只能占工序公差的 1/2，试设计该一面两孔定位方案，确定两销中心距及公差（按 $\delta_{\mathrm{ld}}=\frac{1}{4}\delta_{\mathrm{LD}}$ 选取）、圆柱销直径及公差（按 f7 选取）、菱形销直径及公差，并计算确定该方案能否满足两孔 O_3 和 O_4 的位置精度要求。若不能满足要求，应如何采取措施？

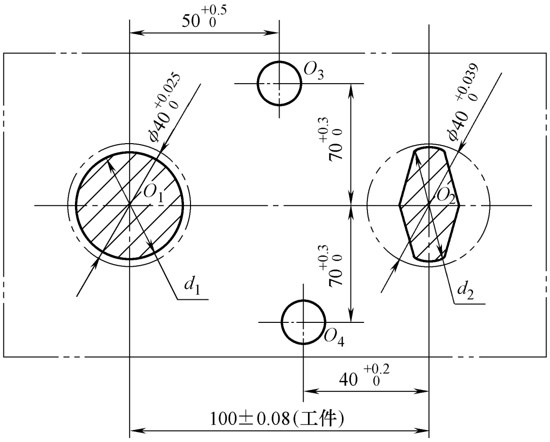


Fig. 4-27 Drilling two holes in a workpiece located on "one plane and two holes"
工件以一面两孔定位钻两孔

25. As shown in Fig. 4-28, a multi-diameter shaft is located on two V-blocks to machine the hole D and the woodruff keyseat. Given that $d_1 = \phi 35^{\ 0}_{-0.17}$mm, $d_2 = \phi 35^{-0.025}_{-0.050}$mm, $L_1 = 80$mm, $L_2 = 30$mm, $L_3 = 120$mm. If ignoring the manufacturing error of V-block, try to calculate the location error for A_1 and A_2 respectively.

图 4-28 所示为阶梯轴在双 V 形块上定位，钻孔 D 及铣半月形键槽。已知 $d_1 = \phi 35^{\ 0}_{-0.17}$ mm，$d_2 = \phi 35^{-0.025}_{-0.050}$mm，$L_1 = 80$mm，$L_2 = 30$mm，$L_3 = 120$mm。若不计 V 形块的制造误差，试计算 A_1 和 A_2 的定位误差。

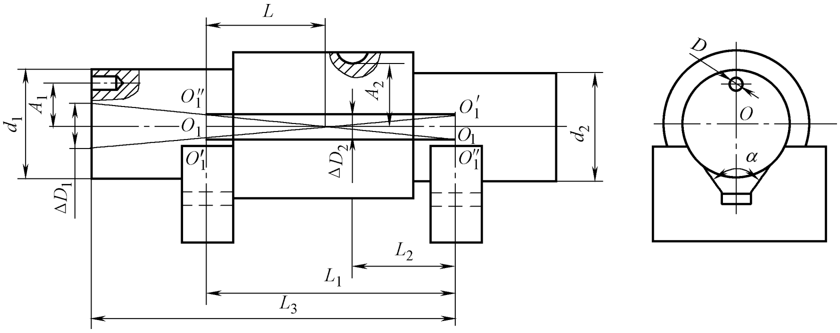


Fig. 4-28 A multi-diameter shaft located on two V-blocks 在 V 形块上定位的阶梯轴

26. In Fig. 4-29, the surface indicated with machining symbol is to be machined. Try to determine respectively the degrees of freedom which should be restricted in Fig. 4-29a, b and c.

图 4-29 中，注有加工符号的表面为待加工表面，试分别确定应限制的自由度。

27. Two holes O_1 and O_2 in a workpiece as shown in Fig. 4-30 are to be machined. It is required that the connection line of two holes should be parallel to the surface C. But A_1 in Fig. 4-30a should be ensured, and A_2 in Fig. 4-30b should be ensured. Given that L is a free dimension, and the other surfaces have been machined. Try to determine a rational location plan for Fig. 4-30a and

Fig4-30b respectively, and draw the location sketches.

欲在图 4-30 所示的零件上加工孔 O_1 和孔 O_2。要求两孔的连心线应与表面 C 平行。但在图 4-30a 中必须保证尺寸 A_1，而在图 4-30b 中必须保证尺寸 A_2. 已知其余表面均已加工好，且尺寸 L 是自由尺寸。试分别确定图 4-30a 和图 4-30b 的合理定位方案，并绘出定位方案草图。

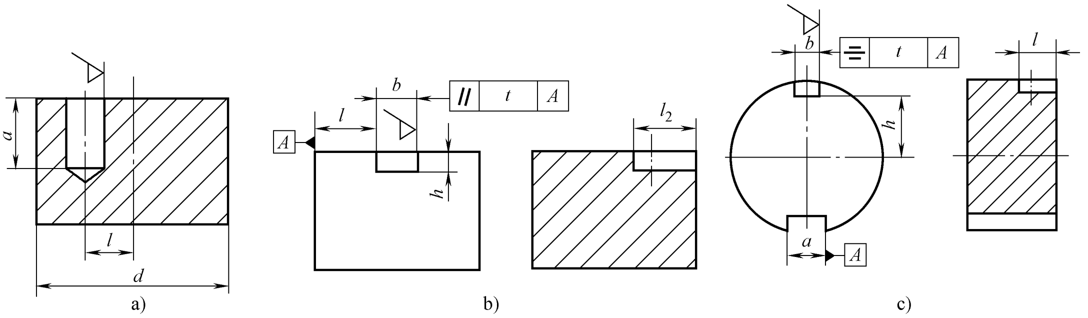


Fig. 4-29 Degrees of freedom which should be restricted 应限制的自由度

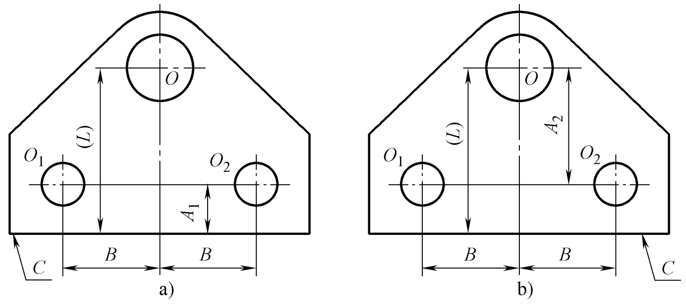


Fig. 4-30 Determination of the location plan 定位方案的确定

28. A face and side milling cutter is used to cut the opening on the workpiece shown in Fig. 4-31 by means of the horizontal milling machine. Given that this operation is the last operation. Try to design a location scheme which can meet the machining requirement.

在卧式铣床上，用三面刃铣刀加工图 4-31 所示零件的缺口。本工序为最后工序。试设计一个能满足加工要求的定位方案。

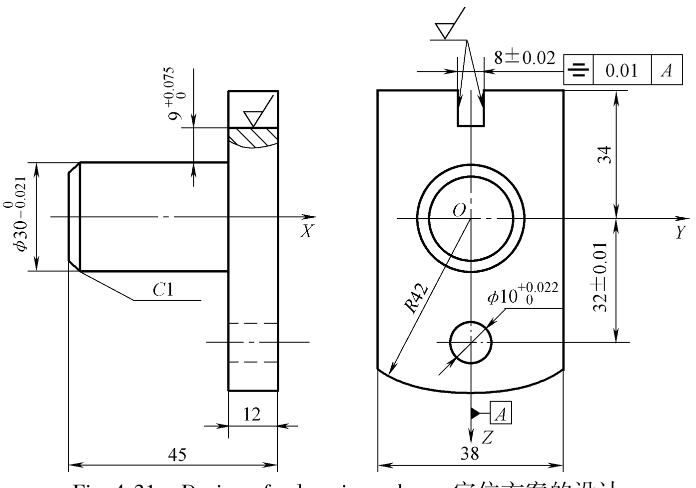


Fig. 4-31 Design of a location scheme 定位方案的设计

Chapter 5

Analysis and Control of Maching Quality

第5章

机械加工质量分析与控制

5.1 English-Chinese Terms 名词英汉对照

1. process system 工艺系统
2. initial error 原始误差
3. machining accuracy 加工精度
4. machining error 加工误差
5. error sensitive direction 误差敏感方向
6. error coping phenomenon 误差复映现象
7. systematical error 系统性误差
8. random error 随机误差
9. spindle revolving error 主轴回转误差
10. contact rigidity 接触刚度
11. forced vibration 强迫振动
12. self-excited vibration 自激振动
13. cold hardening 冷作硬化
14. process capability coefficient 工艺能力系数

5.2 Filling in the blanks 填空题

1. Machining process system consists of ________, ________, ________, ________.
机械加工工艺系统包括________、________、________、________四个方面。

2. Machining accuracy of workpiece includes three contents: _______, _______, ________.
零件的加工精度包括________、________、________三方面的内容。

3. The physical and mechanical properties of surface layer include ______________________, ________________, ____________________.
零件表层的物理力学性能包括____________、____________、____________三方面的内容。

4. The surface qualities of workpiece include __________________, __________________, ____________________ and ____________________.
零件的表面质量包括____________、____________、____________和____________。

5. Vibrations of process system are classified as two categories: ____________ and ____________. The vibration whose amplitude varies with machining variables is ____________.
工艺系统的振动分为____________、____________两大类，其中振幅随切削用量而变的是________。

6. Three basic forms of spindle revolving errorsare ____________, ____________ and ____________.
主轴回转误差的三种基本形式是____________、____________和____________。

7. The thermal sources of process system are divided roughly into internal thermal sources and

external thermal sources. The internal thermal sources include ____________ and ____________; The external thermal sources include ____________ and ____________.

工艺系统的热源大致分为内部热源和外部热源，内部热源包括____________和____________；外部热源包括____________和____________。

8. Based on its statistic law, machining errors are classified as ____________ and ____________, where ____________ can be divided into constant systematic error and variable systematic error.

加工误差按其统计规律可分为____________和____________两大类，其中____________又分为常值系统误差和变值系统误差两种。

9. In machining process, the primary reasons for residual stress of surface are ____________, ____________ and ____________.

在机械加工过程中，引起表面残余应力的主要原因有________、________和________。

10. According to the nature of machining errors, machining errors can be classified as two categories: ____________ and ____________ The manufacturing errors of machine tool belong to ____________, tool wear belong to ____________, the errors caused by the variation of material hardness belong to ____________ .

加工误差按其性质可分为________和________两大类。机床制造误差属于______________，刀具尺寸磨损属于______________，工件材料硬度变化导致的误差为____________。

11. In machining process, the factors of influencing on the surface roughness are ____________, ____________, ____________ .

切削加工中影响表面粗糙度的因素有____________、____________、____________。

12. The form error of outer raceway of spindle bearing has larger influence on the machining accuracy of ____________-type machine tools; the form error of inner raceway has larger influence on the machining accuracy of ____________-type machine tools.

主轴轴承外环滚道的形状误差对____________类机床的加工精度影响较大；内环滚道的形状误差对____________类机床的加工精度影响较大。

13. The pure axial runout of the lathe spindle would cause ________________ error in facing and ____________________ error in threading.

车床主轴轴向窜动使车端面产生____________误差，车螺纹时将造成____________误差。

14. The rigidity of machine tool is the function of cutter position. Generally, the rigidity value when the cutter is in the ____________ position is seen as the average rigidity of machine tool. The methods to measure the rigidity of machine tool are ____________ and ____________ .

机床刚度是刀具位置的函数，一般以刀具在____________位置的刚度值作为机床的平均刚度，测定机床刚度的方法有____________法与____________法。

15. The methods to achieve dimensional accuracy are ____________, ____________, ____________, ____________.

机械加工中获得尺寸精度的方法有____________、____________、____________、

__________四种。

16. Commonly used burnish machining methods are __________, __________, __________, __________.

光整加工常用的方法有__________、__________、__________、__________四种。

17. The measures to improve the precision of machine tool transmission chain are __________, __________, __________, __________.

提高机床传动链精度的措施是__________、__________、__________、__________.

18. Gear shaving can improve the __________ accuracy, reduce __________, but it can't improve the __________ accuracy. Therefore, __________ machining should be used before shaving.

剃齿能提高______精度，减少______，但不能提高______精度。因此剃齿前应采用______加工。

5.3 Making choice 选择题

1. There are a batch of workpieces machined by means of adjusting method. Their dimensions obey the normal distribution, and the center of distribution range coincides with the center of tolerance range. But there are a certain number of rejects, the reason is ____.

A. constant systematic error　　B. random error

C. tool wear　　D. adjusting error

调整法加工一批工件后的尺寸符合正态分布，且分散中心与公差带中心重合，但发现有相当数量的废品，产生废品的原因主要是____。

A. 常值系统误差　B. 随机误差　C. 刀具磨损太大　D. 调整误差大

2. If two guideways of the lathe are not parallel in vertical plane, ____ would present on the cylindrical surface.

A. roundness error　　B. cylindricity error

C. dimensional error　　D. perpendicularity error

若车床两导轨面在垂直面内有扭曲，则外圆产生____。

A. 圆度误差　B. 圆柱度误差　C. 尺寸误差　D. 垂直度误差

3. If the lathe guideway is not parallel to the spindle axis, it would make the workpiece after turning produce ____.

A. dimensional error　　B. positional error

C. cylindricity error　　D. roundness error

车床导轨在水平面内与主轴线不平行，会使车削后的工件产生____。

A. 尺寸误差　B. 位置误差　C. 圆柱度误差　D. 圆度误差

4. The radial runout of lathe spindle would cause the workpiece after boring produce ____.

A. dimensional error　B. coaxial error　C. roundness error　D. conical shape

车床主轴有径向跳动误差，镗孔时会使工件产生____。

A. 尺寸误差圆　　B. 同轴度误差　　C. 圆度误差　　D. 圆锥形

5. If a blank of shaft presents in taper, then the shaft after rough turning produce ____.

A. roundness error　　B. dimensional error

C. cylindricity error　　D. positional error

某轴毛坯有锥度，则粗车后此轴会产生____。

A. 圆度误差　　B. 尺寸误差　　C. 圆柱度误差　　D. 位置误差

6. If the hole of a workpiece after rough boring has cylindricity error, then ____ would produce after semifinish boring.

A. roundness error　　B. dimensional error

C. cylindricity error　　D. positional error

某工件内孔在粗镗后有圆柱度误差，则在半精镗后会产生____。

A. 圆度误差　　B. 尺寸误差　　C. 圆柱度误差　　D. 位置误差

7. A long shaft is supported by two centers for cylindrical turning. If the rigidity of the workpiece is not enough, ____ would present on the shaft after turning.

A. roundness error　　B. dimensional error

C. cylindricity error　　D. positional error

在车床两顶尖间车细长轴外圆，若只考虑工件刚度不足，则加工后会产生的误差是____。

A. 圆度误差　　B. 尺寸误差　　C. 圆柱度误差　　D. 位置误差

8. If the heated workpiece presents in uniform deformation, the thermal deformation would have the workpiece produce ____ .

A. dimensional error　　B. form error

C. positional error　　D. dimension and form error

工件受热均匀变形时，热变形使工件产生的误差是____。

A. 尺寸误差　　B. 形状误差　　C. 位置误差　　D. 尺寸和形状误差

9. In the gear transmission accuracy, ____ would limit the variation of Instantaneous gear angle error.

A. kinematic accuracy　　B. contact precision

C. transmission stability　　D. gear backlash

齿轮传动精度中限制齿轮瞬时转角误差变化的是____。

A. 运动精度　　B. 接触精度　　C. 传动平稳性　　D. 齿侧间隙

10. The frequency of self-excited vibration is ____.

A. equal to the frequency of the vibration source

B. equal to the natural frequency of the system

C. larger than the frequency of the vibration source

D. smaller than the natural frequency of the system

自激振动的频率____。

A. 等于振源频率　　B. 等于系统固有频率

C. 大于振源频率　　D. 小于系统固有频率

11. In order to decrease the depth and hardness of surface hardening layer, the cutting speed

should be ____.

A. decreased　B. middle speed　C. increased　D. keep constant

为减小零件加工表面硬化层深度和硬度，应使切削速度____。

A. 减小　B. 为中速　C. 增大　D. 保持不变

12. In gear hobbing, the motion eccentricity would cause ____.

A. radial error　B. tangential error　C. tooth error　D. base pitch error

滚齿加工时运动偏心会引起____。

A. 径向误差　B. 切向误差　C. 齿形误差　D. 基节偏差

13. The reason for causing base pitch error is ____.

A. gear blank installation error　B. transmission chain error of hobbing machine

C. hob installation error　D. hob lead error

产生基节偏差的原因是____。

A. 齿坯安装误差　B. 滚齿机传动链误差

C. 滚刀安装误差　D. 滚刀的导程误差

14. After turning a shaft, if the end face is not perpendicular to the cylindrical surface, is means the spindle has ____.

A. roundness error　B. pure radial runout

C. pure angular swing　D. pure axial runout

车削加工时轴的端面与外圆柱面不垂直，说明主轴有____。

A. 圆度误差　B. 纯径向圆跳动　C. 纯角度摆动　D. 轴向窜动

15. When the pitch diameter of thread, which is used for fastening and adjusting the rolling bearing on the spindle is not coaxial to the bearing journal, the effect on the spindle is ____.

A. to cause radial runout　B. to cause axial runout

C. to cause angular swing　D. irrelevant

当主轴上用于固定和调节滚动轴承的螺纹中径与支承轴颈不同轴时，对主轴的影响是____。

A 引起径向圆跳动　B. 引起轴向窜动　C. 引起角度摆动　D. 无关系

16. In facing on a lathe, the perpendicularity of the end face to the axis of shaft depend on the ____ .

A. straightness of longitudinal guideway

B. parallelism of longitudinal guideway to the axis of spindle

C. straightness of transverse guideways

D. perpendicularity of transverse guideways to the axis of spindle

在车床上车端面时，端面与轴线的垂直度取决于____。

A. 纵向导轨的直线度　B. 纵向导轨与和主轴轴线的平行度

C. 横向导轨的直线度　D. 横向导轨与主轴轴线的垂直度

17. If the spindle of a boring machine has angular swing in boring, the hole after boring would be ____.

A. round hole　B. elliptical hole　C. conical hole　D. hyperboloid hole

在镗床上镗孔时主轴有角度摆动，镗出的孔将呈现____。

A. 圆孔　B. 椭圆孔　C. 圆锥孔　D. 双曲面孔

18. The ratio of the cutting force perpendicular to the machining surface to the workpiece deformation produced in the direction of the cutting force is defined as the ____ of process system.

A. static rigidity　B. flexibility　C. dynamic rigidity　D. dynamic flexibility

垂直于被加工表面的切削力与工件在该作用方向上所产生的变形的比值定义为工艺系统的____。

A. 静刚度（刚度）　B. 柔度　C. 动刚度　D. 动柔度

19. Under the action of external force, the resistance of workpiece to contact deformation is named as ____.

A. rigidity of process system　B. workpiece hardness

C. contact rigidity　D. fatigue strength

工件受外力时抵抗接触变形的能力，称为____。

A. 工艺系统刚度　B. 工件硬度　C. 接触刚度　D. 疲劳强度

20. The process capability coefficient C_p of grade 1 process is ____.

A. $C_p \leq 0.67$　B. $0.67 < C_p \leq 1$　C. $1 < C_p \leq 1.33$　D. $1.33 < C_p \leq 1.67$

一级工艺的工艺能力系数 C_p 为____。

A. $C_p \leq 0.67$　B. $0.67 < C_p \leq 1$　C. $1 < C_p \leq 1.33$　D. $1.33 < C_p \leq 1.67$

21. The process with reluctant process capability is ____.

A. grade 1 process　B. grade 2 process　C. grade 3 process　D. grade 4 process

工序能力勉强的工艺是____。

A. 一级工艺　B. 二级工艺　C. 三级工艺　D. 四级工艺

22. In grinding variables, the measure to reduce grinding burn is to ____.

A. increase v_{GW}　B. increase v_w　C. decrease f　D. increase a_p

磨削用量中，减少表面烧伤的措施是____。

A. 提高 $v_{砂}$　B. 提高 $v_{工}$　C. 减小 f　D. 增大 a_p

23. The positional error of workpiece ____ corresponding dimensional error.

A. larger than　B. less than　C. equal to　D. larger than or equal to

零件的位置误差____相应的尺寸误差。

A. 大于　B. 小于　C. 等于　D. 大于或等于

24. To improve the geometric accuracy of machine tool used for machining workpiece belongs to ____ .

A. compensating original error　B. counteracting original error

C. reducing original error　D. shifting original error

提高加工工件所用机床的几何精度属于____。

A. 补偿原始误差　B. 抵消原始误差　C. 减小原始误差　D. 转移原始误差

25. The factor to cause variable systematic error is ____.

A. geometric error of process system　B. forced deformation of process system

C. cutting tool wear　　D. tool alignment error

下列因素中造成变值系统性误差的因素是____。

A. 工艺系统几何误差　　B. 工艺系统受力变形

C. 刀具磨损　　D. 对刀误差

26. Geometrical errors include macro-geometry error, micro-geometry error and ____ .

A. surface waviness　　B. surface roughness　　C. surface flatness　　D. surface finish

几何形状误差包括宏观几何形状误差、微观几何形状误差和____。

A. 表面波度　　B. 表面粗糙度　　C. 表面不平度　　D. 表面光洁度

27. Generally speaking, cutting heat is conducted primarily by chip and ____ .

A. workpiece　　B. cutting tool　　C. ambient medium　　D. machine tool

一般来讲，切削热主要是通过切屑和____进行传导的。

A. 工件　　B. 刀具　　C. 周围介质　　D. 机床

28. ____ belongs to the static error of technological system .

A. Machine tool error　　B. Thermal deformation of process system

C、Cutting tool wear　　D. Elastic deformation of process system

工艺系统静误差主要包括____。

A. 工艺系统受力误差　　B. 工艺系统受热误差

C. 机床误差　　D. 刀具磨损

29. The cutters whose manufacturing error have not direct effect on machining accuracy is ____.

A. cylindrical turning tools　　B. form turning tools

C. drills　　D. broaching tools

制造误差不直接影响加工精度的刀具是____。

A. 外圆车刀　　B. 成形车刀　　C. 钻头　　D. 拉刀

30. The reasonable machining error is permitted in the machining of workpiece, this is because ____.

A. it is impossible that there is no machining error in production

B. the workpiece is allowed to have a certain errors

C. the higher the machining accuracy, the higher the manufacturing cost

D. above three reasons

工件在机械加工中允许存在合理的加工误差，这是因为____。

A. 生产中不可能无加工误差　　B. 零件允许存在一定的误差

C. 加工精度要求过高、制造费用太高　　D. 包括上述所有原因

31. Economical accuracy of a machining method means ____.

A. the highest machining accuracy of the method

B. the lowest machining accuracy of the method

C. the machining accuracy obtained under the normal production conditions

D. the machining accuracy with lowest production cost

一种加工方法的经济精度是指____。

A. 这种方法的最高加工精度　　B. 这种方法的最低加工精度

C. 在正常情况下的加工精度　　D. 在最低成本下的加工精度

32. There is no way to improve ____ of hole by floating boring.

A. surface quality　　B. dimensional accuracy

C. form accuracy　　D. positional accuracy

浮动镗孔无法提高孔的____。

A. 表面质量　　B. 尺寸精度　　C. 形状精度　　D. 位置精度

33. In $\overline{X}$-R chart, the sign to estimate that the variation situation is not abnormal fluctuation is ____.

A. some points have gone beyond control line

B. the points have rising or falling trend

C. the points have no obvious regularity

D. the points have the periodic fluctuation

$\overline{X}$-R 图中判断点的变动情况不属于异常波动的标志是____。

A. 有点子超出控制线　　B. 点子有上升或下降倾向

C. 点子没有明显的规律性　　D. 点子有周期性波动

34. The main function of steady rest or follow rest is to increase ____.

A. strength of workpiece　　B. rigidity of workpiece

C. strength of cutter　　D. rigidity of cutter

中心架或跟刀架的主要作用是增强____。

A. 工件的强度　　B. 工件的刚性

C. 刀具的强度　　D. 刀具的刚性

35. In grinding, more grinding heat conducts to ____.

A. workpiece　　B. grinding wheel　　C. chip　　D. air

磨削时磨削热传给较多的是____。

A. 工件　　B. 砂轮　　C. 切屑　　D. 空气

36. In grinding process, most part of cutting heat would conduct to ____ .

A. grinding wheel　　B. machine tool　　C. workpiece　　D. chip

在磨削加工中，大部分切削热将传给____。

A. 砂轮　　B. 机床　　C. 工件　　D. 磨屑

37. The cylindrical surface is held by a self-centering chuck for turning hole on a lathe. It is found after turning that the hole is not coaxial to the cylindrical surface, the possible reason is ____ .

A. radial runout of lathe spindle

B. longitudinal guideway is not parallel to the axis of spindle

C. the working surface of a self-centering chuck is not coaxial to the axis of spindle

D. the height of tool nose is not equal to that of the axis of spindle

在机床上用自定心卡盘装夹工件外圆车内孔，加工后发现孔与外圆不同轴，可能的原因是____。

A. 车床主轴径向跳动

B. 车床纵向导轨与主轴回转线不平行

C. 自定心卡盘装夹面与主轴回转线不同轴

D. 刀尖与主轴回转轴线不等高

38. Generally, the chief reason for producing residual stress on the surface layer of workpiece machined by shaping or planing is ________.

A. cold plastic deformation　　B. thermal plastic deformation

C. elastic deformation　　D. variation of metallurgical structure

一般情况下，刨削加工使工件产生表面层残余应力的主要原因是____。

A. 冷态塑性变形　　B. 热态塑性变形

C. 弹性变形　　D. 金相组织变化

39. In hobbing, the error of transmission chain has chiefly effect on the ____ of gear.

A. smooth performance　　B. tooth accuracy

C. kinematic accuracy　　D. contact accuracy

在滚齿加工中，滚齿机传动链的传动误差主要影响被加工齿轮的____。

A. 平稳性精度　B. 齿形精度　C. 运动精度　D. 接触精度

40. In the following machining methods, ____ belongs to the constant-size cutting tool.

A. drilling　B. hole turning　C. boring　D. hole grinding

下列孔加工方法中，属于定尺寸刀具法的是____。

A. 钻孔　B. 车孔　C. 镗孔　D. 磨孔

41. In order to ensure not producing the rejects in machining process, the range of control line in $\overline{X}$ chart should be ____ the dimension tolerance range.

A. larger than　　B. equal to

C. less than　　D. larger than or equal to

为保证加工过程中不产生废品，$\overline{X}$图中控制线的范围应____加工尺寸公差范围。

A. 大于　B. 等于　C. 小于　D. 大于或等于

42. After turning a straight shaft supported by two centers on a lathe, it is found that the shaft presents a drum shape. The most probable reason is ____ .

A. insufficient rigidity of spindle

B. insufficient rigidity of both headstock and tailstock

C. insufficient rigidity of tool rest

D. insufficient rigidity of workpiece

在车床上用两顶尖装夹车削光轴，加工后检验发现鼓形误差，其最可能的原因是____。

A. 车床主轴刚度不足　　B. 两顶尖刚度不足

C. 刀架刚度不足　　D. 工件刚度不足

43. If there are variable systematic errors, the points on the $\overline{X}$ chart will present ____.

A. random variation B. irregular fluctuation near the control line

C. regular variation D. irregular fluctuation near the center line

当存在变值系统误差时，$\overline{X}$图上的点子将____。

A. 呈现随机性变化 B. 在控制线附近无规律波动

C. 呈现规律性变化 D. 在中心线附近无规律波动

44. In cutting process, the factor which has the largest effect on the surface roughness is ____.

A. cutting tool material B. feed

C. cutting depth D. workpiece material

切削加工时，对表面粗糙度影响最大的因素是____。

A. 刀具材料 B. 进给量 C. 切削深度 D. 工件材料

45. The cracks on the ground surface layer is the result from ____ of surface layer.

A. residual stress B. oxidizing

C. nonuniform material components D. tempering

磨削表层裂纹是表面层____的结果。

A. 残余应力作用 B. 氧化 C. 材料成分不匀 D. 产生回火

46. Generally, the ration of wave length to wave height of the surface roughness is ____ .

A. less than 50 B. equal to 50~200

C. equal to 200~1000 D. larger than 1000

表面粗糙度的波长与波高的比值一般____。

A. 小于 50 B. 等于 50~200 C. 等于 200~1000 D. 大于 1000

47. Original error means the "error source" to cause machining error, i. e. ____.

A. machine tool error B. fixture error

C. cutting tool error D. error of process system

原始误差是指产生加工误差的“源误差”，即____。

A. 机床误差 B. 夹具误差 C. 刀具误差 D. 工艺系统误差

48. Error sensitive direction is the ____ .

A. primary motion direction B. normal direction to the machining surface

C. feed direction D. tangent direction to the machining surface

误差的敏感方向是____。

A. 主运动方向 B. 加工表面的法向 C. 进给方向 D. 加工表面的切向

49. The dimension tolerances of finishing fixtures generally takes the ____ of corresponding dimension tolerance of the workpiece.

A. 1/10~1/5 B. 1/5~1/3 C. 1/3~1/2 D. 1/2~1

精加工夹具的有关尺寸公差常取工件相应尺寸公差的____。

A. 1/10~1/5 B. 1/5~1/3 C. 1/3~1/2 D. 1/2~1

50. If the spindle of boring machine uses sliding bearing, the primary factor of influencing on the revolving accuracy of spindle is ____.

A. roundness of bearing hole

B. roundness of spindle journal

C. clearance between the journal and bearing hole

D. magnitude of cutting force

镗床主轴采用滑动轴承时，影响主轴回转精度的最主要因素是____。

A. 轴承孔的圆度　　B. 主轴轴径的圆度

C. 轴径与轴承孔的间隙　　D. 切削力大小

51. The purpose of turning or grinding the jaws of self-centering chuck on the lathe is to ____.

A. improve the revolving accuracy of spindle

B. decrease the surface roughness of the jaws

C. improve the stability of mounting workpiece

D. ensure the coaxiality between self-centering chuck and spindle axis

在车床上就地车削（或磨削）自定心卡盘的卡爪是为了____。

A. 提高主轴回转精度　　B. 降低自定心卡盘卡爪面的表面粗糙度值

C. 提高装夹稳定性　　D. 保证自定心卡盘卡爪面与主轴回转轴线同轴

52. ____ drive should be used to reduce the effect of driving parts on driving accuracy.

A. raising speed　　B. decreasing speed

C. constant speed　　D. variable speed

为减小传动元件对传动精度的影响，应采用____传动。

A. 升速　　B. 降速　　C. 等速　　D. 变速

53. Generally, the error of the ____ part in transmission chain has the largest effect on the machining error.

A. first　　B. last　　C. middle　　D. either end

通常机床传动链的____传动元件对加工误差影响最大。

A. 首端　　B. 末端　　C. 中间　　D. 任一端

54. Rigidity of process system equals the ____ of the rigidity of each component.

A. sum　　B. sum of reciprocal

C. reciprocal of sum　　D. reciprocal of the sum of reciprocal

工艺系统刚度等于工艺系统各组成环节刚度____。

A. 之和　　B. 倒数之和　　C. 之和的倒数　　D. 倒数之和的倒数

55. Practical rigidity of machine assembly ____ the rigidity estimated based on physical object.

A. larger than　　B. equals　　C. less than　　D. much less than

机床部件的实际刚度____按实体所估算的刚度。

A. 大于　　B. 等于　　C. 小于　　D. 远小于

56. The relation of error duplication coefficient to the rigidity of process system is ____ .

A. direct proportion　　B. inverse ratio

C. exponential relation　　D. logarithmic relation

误差复映系数与工艺系统刚度成____。

A. 正比　　B. 反比　　C. 指数关系　　D. 对数关系

57. In order to reduce the deformation of machine components, attention in the design of components should be paid to ____ .

A. increase the cross section　　B. decrease the ration of length to diameter

C. use the open structure D. use the thermal symmetric structure

为了减小机床零部件的热变形，在零部件设计上应注意____。

A. 加大截面积 B. 减小长径比

C. 采用开式结构 D. 采用热对称结构

58. The relation between the process capability coefficient and the tolerance is ____ .

A. direct proportion B. inverse ratio

C. irrelevant D. a little

工艺能力系数与零件公差____。

A. 成正比 B. 成反比 C. 无关 D. 关系不大

59. The application of dead center on the external grinding machines is to ____.

A. eliminate the effect of roundness of center hole on machining accuracy

B. eliminate the effect of straightness of guideway on machining accuracy

C. eliminate the effect of spindle revolving error on machining accuracy

D. increase the rigidity of process system

外圆磨床上采用固定顶尖是为了____。

A. 消除顶尖孔圆度误差对加工精度的影响

B. 消除导轨直线度误差对加工精度的

C. 消除工件主轴回转误差对加工精度的影响

D. 提高工艺系统刚度

60. When machining the plastic materials, ____ cutting causes easily build-up edge.

A. low speed B. middle speed C. high speed D. superhigh speed

加工塑性材料时，____切削容易产生积屑瘤。

A. 低速 B. 中速 C. 高速 D. 超高速

61. The relation between the frequency of forced vibration and the frequenc of outside interference force is ____ .

A. irrelevant B. close C. equal D. equal or whole multiple

强迫振动的频率与外界干扰力的频率____。

A. 无关 B. 相近 C. 相同 D. 相同或成整倍数关系

62. The anti-vibration principle of cut-to-flat boring bar is ____ .

A. to increase the cross sectional area of boring bar

B. to increase the area moment of inertia of boring bar

C. based on the principle of regenerating self-excited vibration

D. based on the vibration mode coupling principle of self-excited vibration

削扁镗杆的减振原理是____。

A. 镗杆横截面面积加大 B. 镗杆截面矩加大

C. 基于再生自激振动原理 D. 基于振型偶合自激振动原理

63. The frequency of self-excited vibration ____ the nature frequency of process system.

A. is larger than B. is less than

C. equal D. is equal or close to

自激振动的频率____工艺系统的固有频率。

A. 大于　　B. 小于　　C. 等于　　D. 等于或接近于

64. After turning a straight shaft supported by two centers on a lathe, it is found by inspection that the diameter of the middle is less than that of two ends. The most probable reason is ____ .

A. wear of guideways

B. insufficient rigidity of both headstock and tailstock

C. insufficient rigidity of tool rest

D. insufficient rigidity of workpiece

在车床上用两顶尖装夹车削光轴，加工后检验发现中间小、两头大误差，其最可能的原因是____。

A. 车床导轨磨损　　B. 前后两顶尖刚度不足

C. 刀架刚度不足　　D. 工件刚度不足

5.4 True or false 判断题

1. Blank manufacturing error belongs to random error. (　　)

毛坯制造误差属于随机误差。(　　)

2. Workpiece location error belongs to systematic error. (　　)

工件定位误差属于系统性误差 . (　　)

3. The positional accuracy can be obtained by machining in one-time installation or multi-installation. (　　)

零件表面的位置精度可以通过一次装夹或多次装夹加工得到。(　　)

4. If the residual stress of component surface is compressive stress, the anti-fatigue strength of the workpiece can be increased. (　　)

零件表面残余应力为压应力时，可提高零件的疲劳强度。(　　)

5. Machining principle error is not allowed in machining process. (　　)

在机械加工中不允许有加工原理误差。(　　)

6. The residual stress in workpiece has not effect on the machining accuracy. (　　)

工件的内应力不影响加工精度。(　　)

7. The radial runout of spindle would cause the roundness error of the workpiece. (　　)

主轴的径向圆跳动会引起工件的圆度误差。(　　)

8. For the general-purpose lathe, the straightness error of its guideway in vertical plane has little effect on the machining accuracy. (　　)

普通车床导轨在垂直面内的直线度误差对加工精度影响不大。(　　)

9. The contact rigidity can be improved by means of preloading method. (　　)

采用预加载荷的方法可以提高接触刚度。(　　)

10. As long as the process capability coefficient is larger than 1, the reject would not be produced. (　　)

只要工序能力系数大于 1，就可以保证不出废品。(　　)

11. In $\overline{X}$-R chart, as long as there is no point that has exceeded the control line, it shows that the technological process is stable. (　　)

在 $\overline{X}$-R 图中，只要没有点子越出控制限，就表明工艺过程稳定。(　　)

12. The grinding burn can be relieved by increasing grinding depth. (　　)

为减轻磨削烧伤，可加大磨削深度。(　　)

13. The increase of the tool nose radius and the flank wear would cause the hardness and depth of cold hardening layer to increase. (　　)

刀尖圆弧半径和后刀面磨损量增大，将使冷作硬化层硬度及深度增大。(　　)

14. The residual compressive stress produced on the machined surface can increase the fatigue strength of workpieces. (　　)

加工表面层产生的残余压应力，能提高零件的疲劳强度。(　　)

15. The bigger the grain size and the lower the grade of the grinding wheel, the worse the self-sharpness, the higher the grinding temperature. (　　)

砂轮的粒度越大，硬度越低，则自砺性越差，磨削温度越高。(　　)

16. To decrease the feed can decrease the surface roughness. (　　)

减少进给量将减小表面粗糙度值。(　　)

17. The smaller the surface roughness, the better the surface quality. (　　)

表面粗糙度越小，表面质量越好。(　　)

5.5 Short-answer questions　简答题

1. What is the principle error? What are principle errors which have effect on the machining accuracy?

什么是原始误差？影响机械加工精度的原始误差有哪些？

2. What contents does the machining quality include?

加工质量包括哪些内容？

3. What are the factors which have effect on the machining accuracy?

影响加工精度的因素是什么？

4. What are the factors of influencing on surface roughness?

影响表面粗糙度的因素是什么？

5. How is the machining principle error formed? Whether the machining principle error is permitted existing in the machining process?
加工原理误差是如何产生的？是否允许加工中存在加工原理误差？

6. What aspects do the geometric errors of machine tool include?
机床几何误差包括哪几个方面？

7. What factors do they cause the spindle revolving error?
主轴回转误差都是由哪些因素引起的？

8. What are the effects of surface roughness on the service performance of machine?
表面粗糙度对机床的使用性能有哪些影响？

9. What are three types of spindle revolving errors? What are the influences of them on the machining accuracy?
主轴回转误差有哪三种类型？它们对加工精度有何影响？

10. What is the distribution curve of workpieces? What are the physical meaning of σ and $\bar{x}$?
何谓零件的分布曲线？σ 和$\bar{x}$的物理意义是什么？

11. Why is the practical distribution range of normal distribution curve thought to be $\pm 3\sigma$? What does the 6σ represent?
为什么标准正态分布的实际分散范围被认为是$\pm 3\sigma$？6σ 代表什么意思？

12. What are the applications of distribution curve? What are the short comings of distribution curve?
分布曲线法都有哪些用途？分布曲线法有哪些缺点？

13. Both point diagram and distribution curve use the statistic method to analyze the workpiece machining accuracy. What are the differences between them in the emphases of analyzing problems?
点图法和分布曲线法都是利用统计方法来分析零件的加工精度，但两者分析问题的重点有何不同？

14. Why should the $\overline{X}$-R chart be used jointly to control the machining accuracy?
为什么要用$\overline{X}$-R 图联合控制加工精度？

15. What is the error sensitive direction? What are the differences between lathe and boring machine in the error sensitive direction?
何谓误差敏感方向？车床与镗床的误差敏感方向有何不同？

16. For the horizontal lathes, it is required that the straightness error of guideway in horizontal plane be less than that in vertical plane, but the requirement for the guideway of surface grinding machine is contrary to the horizontal lathes. Why?
为什么要求车床床身导轨在水平面内的直线度误差小于垂直面内的直线度误差？而对于平面磨床的床身导轨要求则相反？

17. What is the spindle revolving accuracy? Why does the center in the headstock of cylindrical grinder not rotate together with the workpiece, whereas the center in the headstock of lathe rotate together with the workpiece?
什么是主轴回转精度？为什么外圆磨床头架中的顶尖不随工件一起回转，而车床主轴箱中的顶尖则是随工件一起回转的？

18. What are the relationships between the rigidity of process system and the rigidity of each component?
工艺系统刚度与各组成部分刚度的关系是什么？

19. What are the factors of influencing on the rigidity of the machine assembly? Why is the rigidity of the machine assembly much less than the rigidity estimated based on physical object?
影响机床部件刚度的因素有哪些？为什么机床部件的刚度远比其按实体估计的要小？

20. How is the error duplication rule used to test the the rigidity of the machine tool? How to reduce the influence of blank error on machining accuracy?

如何利用误差复映规律来测试机床刚度？如何减小毛坯误差对加工精度的影响？

21. What are the effects of surface quality of workpiece on the service performances of machine?

零件加工表面质量对机器的使用性能有哪些影响？

22. What are the chief measures to improve machining accuracy?

提高加工精度的主要措施有哪些？

23. What are the factors of influencing on the surface roughness? How to reduce the surface roughness?

影响切削加工表面的表面粗糙度的因素有哪些？如何减小加工表面的表面粗糙度值？

24. What is the forced vibration in machining process? What are the features of it? What are the measures to eliminate and control the forced vibration?

什么是机械加工的强迫振动？它有什么特点？消除和控制强迫振动的措施有哪些？

25. What is the self-excited vibration in machining process? What are the features of it? What are the measures to control it?

何谓机械加工中的自激振动？它有什么特点？控制自激振动的措施有哪些？

26. What are the reasons for generating grinding burn? How to avoid it?

产生磨削烧伤的原因有哪些？如何避免磨削烧伤？

27. What are the reasons for generating residual stress?

引起表面残余应力的原因有哪些？

28. Whether are the reasons for producing residual stress on the surface machined by grinding and by cutting are the same? Why?

磨削加工工件表面层产生残余应力的原因与切削加工产生残余应力的原因是否相同？为什么？

29. Why would be the cold hardening generally produced in cutting process?

为什么切削加工中一般都会产生冷作硬化现象？

30. What type of machine tool's machining accuracy does the form error of outer race of spindle bearing have larger influence on? Why?

主轴轴承外环滚道的形状误差对哪一类机床的加工精度影响较大？为什么？

31. What is the process capability coefficient? What is the meaning of it? How to adjust the machining method and process equipment based on the process capability coefficient?

什么是工艺能力系数？它的意义是什么？如何根据工艺能力系数调整加工方法及设备？

5.6 Analysis and calculation 分析与计算题

1. Take the lathe for example, indicate how about the influences of the geometrical errors of machine tool on the workpiece machining accuracy.

以车床为例，说明机床几何误差对零件的加工精度会产生怎样的影响.

2. A hole of box is machined by a horizontal boring machine. There are four boring forms, as shown in Fig. 5-1. If the rigidity of boring bar is considered only, try to analyze the geometries obtained by each boring form and make explanation.

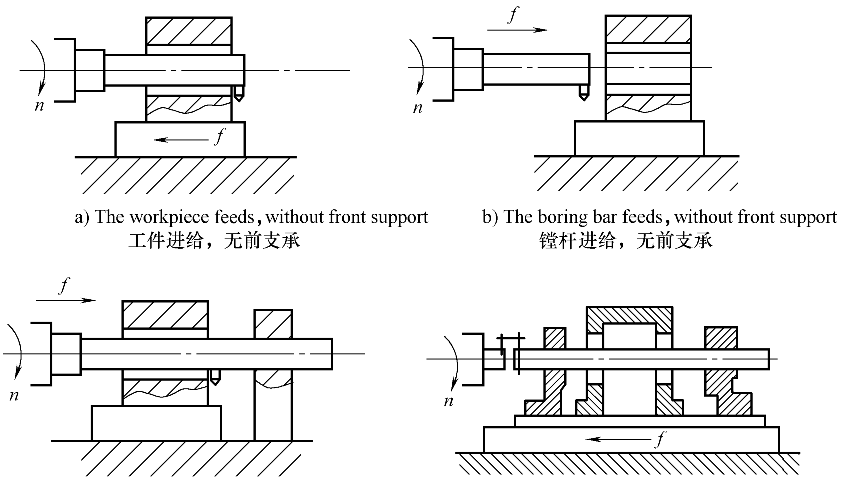
a) The workpiece feeds, without front support。

b) The boring bar feeds, without front support。

c) The boring bar feeds with a front support。

d) The workpiece feeds, the boring bar is supported by the front and back supports.

在卧式镗床上镗一箱体孔。图 5-1 所示为四种镗孔方式。如果只考虑镗杆刚度的影响，试分析每种镗孔方式所获得孔的几何形状，并做出解释。



a) The workpiece feeds, without front support 工件进给，无前支承

b) The boring bar feeds, without front support 镗杆进给，无前支承

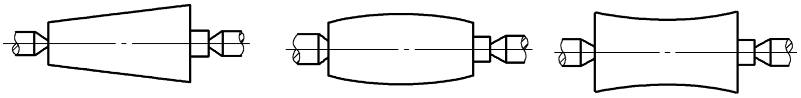
c) The boring bar feeds with a front support 镗杆进给，有前支承

d) The workpiece feeds, the boring bar is supported by the front and back supports 工件进给，镗杆有前、后支承

Fig. 5-1 Four boring forms 四种镗孔方式

3. Three lathes are used to machine separately a batch of shafts between centers. After turning, it is found by inspecting that the three batches of shafts present respectively different form errors, as shown in Fig 5-2. Try to analyze the possible reasons separately for each form error illustrated in Fig. 5-2.

使用三台车床各车削一批光轴。加工后经测量发现这三批光轴分别出现不同的形状误差，如图 5-2 所示。试分别分析产生这种形状误差的主要原因。分别应采用什么办法来减小或消除？



a) Cone shape 锥形　　b) Drum shape 鼓形　　c) Saddle shape 鞍形

Fig. 5-2 Form errors produced when turning long shaft on a center lathe
在车床上车削长轴时产生的形状误差

4. Try to analyze the possible reasons for the following errors.

(1) The roundness error and the cylindricity error are produced when boring a hole on the lathe.

(2) The coaxial error between the hole and the external cylindrical surface and the perpendicularity error between end face and external cylindrical surface are produced when boring hole by means of self-centering chuck of the lathe.

试分析在车床上加工时产生下述误差的原因：

(1) 在车床上镗孔时，引起被加工孔圆度误差和圆柱度误差。

(2) 在车床上用自定心卡盘装夹工件镗孔时，引起内孔与外圆同轴度误差、端面与外圆的垂直度误差。

5. Try to analyze the possible reasons for the roundness error produced when boring hole on boring machine.

试分析在镗床上镗孔时产生圆度误差的原因。

6. The form errors shown in Fig. 5-3 occur when facing on the lathe. Try to point out separately the possible reasons for the form errors.

在车床上车削工件端面时出现图 5-3 所示形状误差，试分别指出造成这种端面几何形状误差的原因。

a) Conical frustum锥台　　b) Plane cam平面凸轮

Fig. 5-3 Form errors occurred in facing 车端面时出现的形状误差

7. Given that the error duplication coefficient of a process system is 0. 25, the cylindricity error of the workpiece before this operation is 0. 45mm. If it is required that the form error of this operation should not be larger than 0. 01mm, then how many feed times are needed at least in order to ensure the form accuracy?

设已知一工艺系统的误差复映系数为 0. 25，工件在本工序前有圆柱度误差 0. 45mm。若本工序形状精度规定公差为 0. 01mm，则至少进给几次才能使形状精度合格？

8. A batch of shafts with the sizes ϕ60mm×120mm are machined between two centers of the lathe. Suppose the diameter error of blank is ±1mm. The cutting variables ($a_p = 3$mm, $v = 100$m/min, $f = 1$mm/r) are used. Given that the radial cutting force $F_p = C_{Fp} a_p f^{0.84} = 1\ 640\ a_p f_{0.84}$, and the rigidity of process system is 12000N/mm, then how large the roundness error is if the excess material is removed by one feed? How large the roundness error is if the excess material is removed by

two feeds?

在车床的两顶尖间车削一批尺寸为 ϕ60mm×120mm 的轴。假设毛坯的直径误差为±1mm。所采用的切削用量为 $a_p=3\text{mm}$，$v=100\text{m/min}$，$f=1\text{mm/r}$。已知径向切削力 $F_p=C_{Fp}a_pf^{0.84}=1640a_pf^{0.84}$，工艺系统刚度为 12000N/mm，如果用一次进给切除所有的加工余量，那么产生的圆度误差会有多大？如果采用两次进给切除这些加工余量，产生的圆度误差又会是多少？

9. A workpiece with large rigidity is ground transversely, as shown in Fig. 5. 4. Given that the radial grinding force is 100N, the rigidity of headstock and tailstock is 50000N/mm and 40000N/mm respectively. Try to analyze the workpiece shape after grinding and calculate the form error.

横向磨削图 5-4 所示的一个刚度很大的工件，若径向磨削力为 100N，头架与尾座的刚度分别为 50000N/mm 和 40000N/mm，试分析加工后工件的形状，并计算形状误差。

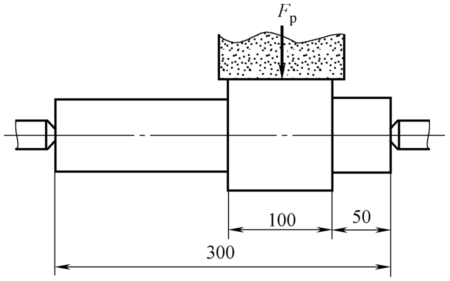


Fig. 5-4 Transverse grinding of a shaft 轴的横向磨削

10. When the adjusting method is used to turn a long shaft, as shown in Fig. 5-5, try to answer the following questions:

1) What shape the shaft machined would be if the guide way of the lathe is not parallel to the revolving line of spindle in the horizontal plane?

2) What shape the shaft machined would be if the guide way has the straightness error in the horizontal plane?

3) What shape the shaft machined would be if the guide way has the straightness error in the vertical plane?

4) Under the action of radial cutting force, when the rigidity of the lathe is considered only, if the rigidity of the headstock is larger than that of tailstock, what shape the machined shaft would appear? When the rigidity of workpiece is considered only, what shape the machined shaft would appear?

在车床两顶尖间加工一根长轴的外圆，如图 5-5 所示，当用调整法车削时，试分析：

(1) 当机床导轨与主轴回转轴线在水平面内不平行时，车出的工件是什么形状？

(2) 导轨在水平面内的直线度误差将使工件产生什么样的形状误差？

(3) 导轨在垂直面内的直线度误差将使工件产生什么样的形状误差？

(4) 在背向切削力作用下，当只考虑车床刚度的影响时，若头架刚度大于尾座刚度，工件将呈什么形状？若只考虑工件刚度的影响，工件将呈什么形状？

11. As shown in Fig. 5-6, a shaft is hold by the self-centering chuck so as to turn the cylindri-

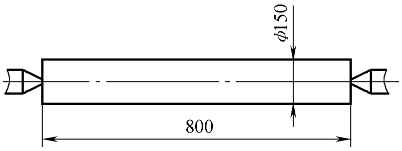


Fig. 5-5 A long shaft 长轴

cal surface and the shoulder side. After turning, it is found by inspection that the cylindrical surface has the cylindricity error, and the shoulder face is not vertical to the axis of the shaft. From the view of geometric error of machine tool, try to analyze the main reasons for above errors.

在车床上用自定心卡盘夹持一轴类零件车外圆及台阶面，如图 5-6 所示。经检测发现外圆面有圆柱度误差，台阶面对外圆轴线有垂直度误差。试从机床几何误差的影响的角度，分析产生以上误差的主要原因。

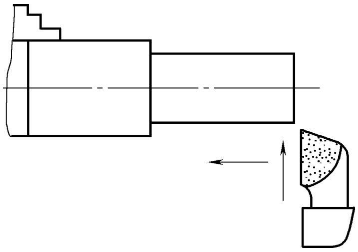


Fig. 5-6 Turning a shaft with a shoulder 车阶梯轴

12. A hole of thin-wall sleeve is machined on a lathe, as shown in Fig. 5-7. After turning, inspection results show there are some errors as follows:

① diameter error;

② hole form error;

③ concentricity error.

Try to analyze the main causes to generate these errors respectively.

如图 5-7 所示，在车床上加工一个薄壁套筒的孔。加工后检测发现有如下一些加工误差。

① 孔径误差。

② 孔的形状误差。

③ 内外圆同轴度误差。

试分别分析产生上述误差的主要原因。

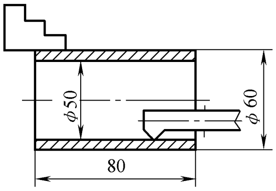
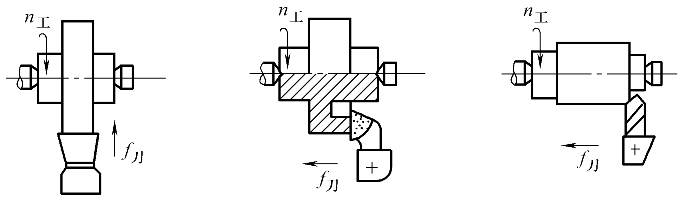


Fig. 5-7 Boring hole on a lathe 在车床上镗孔

13. Fig. 5-8 shows 3 machining conditions. If the rigidity of workpiece is quite large, and the rigidity of headstock is larger than that of tailstock, try to analyze respectively what kind of form error would occur after turning the surface.

图 5-8 所示为三种加工情况，假设工件刚度很大，且车床头架刚度大于尾座刚度，试分析加工后工件表面会产生何种形状误差？



a) Form turning 成形车削　　b) Facing 车端面　　c) Cylindrical turning 车外圆

Fig. 5-8　Turning operations 车削加工

14. Given that the hole diameters of a batch of workpieces are $\phi 70^{+0.03}_{0}$ mm, and obey the normal distribution. Try to calculate the probability in the range of ϕ70. 01 ~ ϕ70. 03mm.

有一批零件，其内孔尺寸为 $\phi 70^{+0.03}_{0}$ mm，属正态分布。试求尺寸在 ϕ70. 01 ~ ϕ70. 03mm 之间的概率。

15. A batch of shafts with the diameter of ϕ (8±0. 090) mm are to be machined by means of an automatic lathe. After trial cutting 50 pieces, diameters of the machined shafts are measured. Measuring results are listed as follows:

7. 920,	7. 970,	7. 980,	7. 990,	7. 995,	8. 005,	8. 018,	8. 030,	8. 068,	7. 935,	7. 970,	7. 982,
7. 991,	7. 998,	8. 007,	8. 022,	8. 040,	8. 080,	7. 940,	7. 972,	7. 985,	7. 992,	8. 000,	8. 010,
8. 022,	8. 040,	7. 957,	7. 975,	7. 985,	7. 992,	8. 000,	8. 012,	8. 028,	8. 045,	7. 960,	7. 975,
7. 988,	7. 994,	8. 002,	8. 015,	8. 024,	8. 028,	7. 965,	7. 980,	7. 988,	7. 995,	8. 004,	8. 027,
8. 065,	8. 017										

Try to plot the practical distribution curve (histogram) and calculate the process capability coefficient C_p. If the permitted reject rate in this operation is 3%, whether can the precision of the machine tool meet the requirement?

欲在一台自动车床上车削一批直径为 ϕ (8±0. 090) mm 的轴。试切 50 件后测量加工过的轴径。测量结果如下：

7. 920, 7. 970, 7. 980, 7. 990, 7. 995, 8. 005, 8. 018, 8. 030, 8. 068, 7. 935, 7. 970, 7. 982, 7. 991, 7. 998, 8. 007, 8. 022, 8. 040, 8. 080, 7. 940, 7. 972, 7. 985, 7. 992, 8. 000, 8. 010, 8. 022, 8. 040, 7. 957, 7. 975, 7. 985, 7. 992, 8. 000, 8. 012, 8. 028, 8. 045, 7. 960, 7. 975, 7. 988, 7. 994, 8. 002, 8. 015, 8. 024, 8. 028, 7. 965, 7. 980, 7. 988, 7. 995, 8. 004, 8. 027, 8. 065, 8. 017

试绘制实际分布曲线图（折线图），并计算其工艺能力系数 C_p。如果本道工序允许的废品率是 3%，请问该机床的精度能否满足加工要求？

16. There are a batch of shafts with ϕ (20±0. 07) mm on the design drawing. Suppose the machined dimensions obey the normal distribution, it is found after machining that the reject rate is 8%, where the diameters of a half of rejects are smaller than the minimum diameter of the workpiece. Try to determine the machining disperse range of this operation.

加工一批工件的外圆，图样要求尺寸为 ϕ（20±0. 07）mm。若加工尺寸按正态分布，加工后发现有 8%的工件为废品，且其中一半废品的尺寸小于零件的下偏差。试确定该工序能达到的加工精度。

17. A batch of shafts are turned on a lathe. It is found by inspection that the numbers of shafts whose practical diameters are larger than the requisite diameter takes up 24% of total, and the numbers of shafts whose practical diameters are smaller than the requisite diameter takes up 2% of total. Suppose the diameter tolerance T of the shafts is 0. 16mm, the practical diameters of total shafts obey the normal distribution, try to calculate the root-mean-square deviation σ, and determine how large the cutter setting error is.

在车床上车削一批小轴，经测量实际尺寸大于要求尺寸的小轴数占 24%，小于要求尺寸的小轴数占 2%。若小轴的直径公差 T=0. 16mm，整批工件的实际尺寸按正态分布，试确定该工序的均方差 σ，并判断车刀的调整误差为多少。

18. A batch of shafts with（25±0. 05）mm in diameter have been machined on a lathe. Given that the machining error distribution curve of this operation obey the normal distribution, and its root-mean-square deviation $\sigma = 0.025$mm, the position of the curve peak located on the left side of the center of tolerance band, and is 0. 01mm far from the middle of tolerance band. Try to calculate the qualification rate and reject rate of these shafts. How to set the process system so that the reject rate can be decreased?

车削一批轴的外圆，其尺寸 $d = (25 \pm 0.05)$ mm。已知此工序的加工误差分布曲线是正态分布，其标准偏差 $\sigma = 0.025$mm，曲线的顶峰位置偏于公差带中心的左侧 0. 01mm。试求零件的合格率、废品率。工艺系统经过怎样的调整可使废品率降低？

19. A batch of shafts whose diameters are ϕ（11±0. 02）mm are machined by means of the same two automatic lathes. 1000 pieces are machined in one lathe. The measured diameters followed the normal distribution, and its mean dimension $\overline{x_1} = 11.005$mm, and the root-mean-square deviation $\sigma_1 = 0.004$mm. 500 pieces are machined in second lathe. The diameters measured also followed the normal distribution, and $\overline{x_2} = 11.015$mm, $\sigma_2 = 0.0025$mm.

（1）Plot the dimension distribution diagrams of two batches of workpieces machined in two lathes in the same drawing, and point out which machine tool has higher precision.

（2）Calculate the reject rate of products produced by two machines separately. Analyze its reason and put forward the improving methods.

用两台相同的自动车床加工一批直径为 ϕ（11±0. 02）mm 的轴。用其中的一台车床加工了 1000 件，测量得到的直径服从正态分布，其平均尺寸 $\overline{x_1} = 11.005$mm，均方差为 $\sigma_1 = 0.004$mm。用另一台车床加工了 500 件，测得的直径同样也服从正态分布，其平均尺寸 $\overline{x_2} = 11.015$mm，均方差 $\sigma_2 = 0.0025$mm。

（1）把用这两台车床加工的两批零件的尺寸分布曲线绘制在同一张图上，指出哪一台车床的精度更高一些。

（2）分别计算两台机床所加工零件的废品率。分析其产生的原因并提出改进的方法。

20. A batch of small shafts whose diameters are ϕ（12±0. 01）mm are being ground by centerless grinding machine. 100 shafts are extracted at random and inspected. It is found that the ODs of the shafts followed the normal distribution on the whole, its mean value $\bar{x} = 11.99$mm, the root-mean-square deviation $\sigma = 0.003$mm. Try to:

(1) Plot the OD error distribution diagrams of the small shaft.

(2) Calculate the process capability coefficient of this operation.

(3) Estimate the reject rate of this operation; analyze the reasons for rejects and propose the solutions.

在无心磨床上磨削一批小轴，其外径尺寸要求为 ϕ（12±0.01）mm。现随机抽取 100 件进行测量，结果发现其外径尺寸大致上服从正态分布，平均值 $\bar{x}=11.99$mm，均方根偏差 $\sigma=0.003$mm。试：

(1) 画出小轴外径尺寸误差的分布曲线。

(2) 计算该工序的工艺能力系数。

(3) 估计该工序的废品率；分析产生废品的原因，并提出解决办法。

21. Turning a batch of small shafts on a lathe, the requirement for diameter is $\phi 20_{-0.1}^{\ 0}$mm. If the measured operation dimensions followed the nomal distribution, its root-mean-square deviation $\sigma=0.025$mm, the center of tolerance band located on the left side of the distribution center, departure distance is 0.03mm. Try to calculate the reject rate of the batch of small shafts.

在车床上加工一批小轴的外圆，尺寸要求为 $\phi 20_{-0.1}^{\ 0}$mm。若测得的工序尺寸服从正态分布，其均方差 $\sigma=0.025$mm，公差带中心位于分布曲线中心左侧，偏移距离为 0.03mm。试计算不合格品率。

22. A shaft made of casting iron is to be machined by means of turning. Suppose the feed f = 0.5mm/r, the cutter nose radius r_{ε} = 0.4mm, how large surface roughness can this machining method obtain?

车削一铸铁零件的外圆表面，若进给量 f=0.5mm/r，车刀刀尖的圆弧半径 r_{ε}=0.4mm，求能达到的加工表面粗糙度值。

23. There is a casting with uneven wall thickness, as shown in Fig. 5-9. After the thin wall is cut off by a circular saw blade, what deformation would the casting generate?

图 5-9 所示为一壁厚不均匀的铸件。在其薄壁处用宽度为 C 的锯片铣刀铣开后铸件将如何变形？

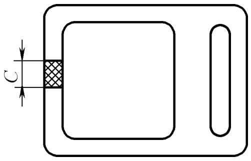


Fig. 5-9　Casting 铸件

24. How do you use the regenerating vibration principle and the vibration mode coupling principle to explain self-excited vibration?

如何用再生振动原理和振型耦合原理解释自激振动?

25. In turning operation, the workers often encounter some troubles, such as tool breakage, excessive tool wear, rough surface finish and so on, which are listed in the Tab. 5-1. Try to analyze what probable causes are and fill them in corresponding place in the Table. Please suggest remedies for the problems and explain why you are making these suggestions.

在车削操作中，操作者常遇到一些麻烦问题，如刀具崩刃、刀具过量磨损、表面粗糙等，详见表 5-1. 试分析其产生的可能原因，并把它们填入表中对应的位置。请提出解决这些问题的办法，并说明你所提建议的理由。

Table 5-1 Troubles encountered in turning operation and probable causes 车削中遇到的问题及其原因

Problem 问题	Probable causes 可能原因
Tool breakage 崩刃	
Excessive tool wear 过度磨损	
Rough surface finish 表面粗糙	
Dimensional variability 尺寸变化	
Tool chatter 刀具颤振	

26. In drilling operation, the workers often encounter some troubles, such as tool breakage, excessive drill wear, tapered hole, oversize hole, poor surface finish and so on, which are listed in the Tab. 5-2. Try to analyze what probable causes are and fill them in corresponding place in the Table. Please suggest remedies for the problems and explain why you are making these suggestions.

在钻削操作中，操作者常遇到一些麻烦问题，如崩刃、钻头过度磨损、孔呈锥形、孔尺寸超差、表面粗糙等，详见表 5-2. 试分析其产生的可能原因，并把它们填入表中对应的位置。请提出解决这些问题的办法，并说明你所提建议的理由。

Table 5-2 Troubles encountered in drilling operation and probable causes
钻削中遇到的问题及其原因

Problem 问题	Probable causes 可能原因
Tool breakage 崩刃	
Excessive drill wear 过度磨损	
Poor surface finish 表面粗糙	
Dimensional variability 尺寸变化	
Tool chatter 刀具颤振	

Chapter 6

Fundamentals of Machine Assembly Technology

第6章

机械装配技术基础

6.1 English-chinese Terms 名词英汉对照

1. assembly 装配
2. assembly accuracy 装配精度
3. assembly cell 装配单元
4. combined member 合件
5. subassembly 组件
6. assembly 部件
7. subassembly assembling 组件装配
8. unit assembling 部件装配
9. general assembling 总装配
10. interchangeable assembly method 互换装配法
11. selection assembly method 选择装配法
12. individual fitting assembly method 修配装配法
13. adjusting assembly method 调整装配法
14. assembly dimensional chain 装配尺寸链
15. coordination link 协调环
16. fitting link 修配环
17. shortest route principle of assembly dimensional chain 装配尺寸链的最短路线原则
18. grouping assembly method 分组装配法

6.2 Filling in the blanks 填空题

1. Machine quality depends chiefly on the correctness of machine design, machining quality of parts and ____________________.

机器的质量主要取决于机器设计的正确性、零件加工质量和____________。

2. The assembly methods to ensure assembly accuracy are interchangeable assembly method, selective assembly method, ____________ method and ____________ method.

保证装配精度的方法有互换法、选配法、____________和____________。

3. When finding out assembly dimensional chain, ____________ dimensions for each related workpiece and assembly as the component link of assembly dimensional chain.

查找装配尺寸链时，每个相关零、部件有一个尺寸作为组成环列入装配尺寸链。

4. Assembly accuracy of a product includes relative position accuracy, ________ and ________.

产品的装配精度包括尺寸精度、位置精度、________和________。

5. The method to ensure assembly accuracy through changing the regulation parts with different dimensions is called ____________ adjusting method.

采用更换不同尺寸的调整件以保证装配精度的方法称为____________调整法。

6. In the interchangeable assembly method, extreme value method is suitable for ________, probability method is suitable for ________________ .

在互换装配法中，极值法适用于____________场合，概率法适用于____________场合。

7. The assembly accuracy of a machine depends not only on the ____________________, but on the____________________________.

机器的装配精度不但取决于__________，而且取决于__________。

8. The interchangeable assembly method means that assembly accuracy still can be ensured by taking any mating part into assembly without______or______ in assembling operation.

互换法就是在装配时各配合零件不经______或______即可达到装配精度的方法。

9. For the individual fitting assembly method, the principle to choose fitting link is______, easy to machine and______.

对于修配装配法，选择修配环的原则是__________、易加工、______。

10. Two organizational forms in assembly process are______and______.

装配的两种组织形式是______________和____________。

6.3 Making choice 选择题

1. Completely interchangeable assembly method is generally suitable for ____ .

A. large volume and mass production

B. the dimensional chains with high accuracy and more component links.

C. the dimensional chains with high accuracy and less component links.

D. job and small volume production

用完全互换法装配机器一般适用于____的场合。

A. 大批大量生产　　B. 高精度多环尺寸链

C. 高精度少环尺寸链　　D. 单件小批生产

2. In assembly relationship, the dimensions and positional relations of components, which have direct effect on the assembly accuracy, are the ____ of assembly dimensional chain.

A. component link　　B. increasing link

C. decreasing link　　D. closing link

在装配关系中，对装配精度有直接影响的零件、部件的尺寸和位置关系，都是装配尺寸链中的________。

A. 组成环　　B. 增环　　C. 减环　　D. 封闭环

3. Assembly method in which the assembly accuracy depends mainly on the workpiece machining accuracy and assembly method is ____ .

A. interchangeable assembly method

B. selective assembly method

C. adjusting assembly method

D. individual fitting assembly method

装配精度主要取决于零件加工精度的装配方法是____。

A. 互换法　B. 选配法　C. 调整法　D. 修配法

4. In mass production, the assembly method named as ____ is often used for the assemblies with less components (2) and higher accuracy.

A. completely interchangeable assembly method

B. grouping assembly method

C. adjusting assembly method

D. probability method

大批大量生产中，对于组成环数少（2 个）而装配精度要求又很高的部件，常采取____。

A. 完全互换法　B. 分组装配法

C. 调整法　D. 概率法

5. The use of assembly dimensional chain is because the assembly accuracy has to do with ____.

A. the accuracy of several workpieces　B. the accuracy of a key workpiece

C. production output　D. tools used in assembling operation

装配尺寸链的出现是由于装配精度与____有关。

A. 多个零件的精度　B. 一个主要零件的精度

C. 生产量　D. 所用的装配工具

6. The interchangeable assembly method is often used in the dimensional chains with high accuracy and—component links or low accuracy and ____ component links.

A. more, more　B. less, less

C. more, less　D. less, more,

互换装配法一般多用于高精度____环尺寸链或低精度____环尺寸链中。

A. 多、多　B. 少、少　C. 多、少　D. 少、多

7. The grouping assembly method is suitable for the assemblies with less components and higher accuracy in ____ .

A. job production　B. small volume production

C. middle volume production　D. large volume and mass production

分组装配法适用于组成环不多，而装配精度要求高的____场合。

A. 单件生产　B. 小批生产　C. 中批生产　D. 大批大量生产

8. The constitution of assembly dimensional chain depends on ____ .

A. component structure design　B. assembly process plan

C. machining method　D. numbers of components

装配尺寸链的构成取决于____

A. 零部件结构设计　B. 工艺过程方案

C. 具体加工方法　D. 零件数量

9. The method to ensure assembly accuracy by changing the position of workpiece in machine through movement or rotation is ____ .

A. movable adjusting method　B. stationary adjusting method

C. Error counteraction adjusting method D. individual fitting method

通过移动或旋转来改变零件在机器中的位置以达到装配精度的方法称为____。

A. 可动调整法 B. 固定调整法

C. 误差抵消调整法 D. 修配法

10. The movable type assembly is most often used for ____ .

A. job production B. the product with low output

C . the product with large output D. different volume productions

移动式装配多用于____。

A. 单件生产 B. 产量小的产品

C. 产量大的产品 D. 各种批量生产

11. Transfer-line assembly is most often used for ____.

A. the product with low output B. the product with large output

C. different volume productions D. job and small volume production

流水式装配大多用于____。

A. 产量较小的产品 B. 产量较大的产品

C. 各种批量生产 D. 单件小批生产

12. The assembly system chart shows ____ .

A. assembly process B. constitution of assembly system

C. layout of assembly system D. machine assembly structure

装配系统图表示了____。

A. 装配过程 B. 装配系统组成

C. 装配系统布局 D. 机器装配结构

13. ____ is widely used in the assembly of automobiles and tractors.

A. interchangeable assembly method B. Probability method

C. Grouping assembly method D. Individual fitting method

汽车、拖拉机装配中广泛采用____。

A. 完全互换法 B. 大数互换法

C. 分组选配法 D. 修配法

14. ____ is often used in the assembly of the inner and outer ring with the rolling element of rolling bearings with higher precision.

A. Interchangeable assembly method B. Probability method

C. Grouping assembly method D. Individual fitting method

高精度滚动轴承内外圈与滚动体的装配常采用____。

A. 完全互换法 B. 大数互换法

C. 分组选配法 D. 修配法

15. ____ is often used in the assembly of a machine spindle.

A. Interchangeable assembly method B. Probability method

C. Individual fitting method D. Adjusting assembly method

机床主轴装配常采用____。

A. 完全互换法 B. 大数互换法
C. 修配法 D. 调节法

16. The shortest route principle in establishing assembly dimensional chain is also called ____ principle.

A. closed dimensional chain B. partial interchanging
C. one component one link D. least mean value

建立装配尺寸链的最短路线原则又称____原则。

A. 尺寸链封闭 B. 部分互换
C. 一件一环 D. 平均尺寸最小

17. The part tolerance in the individual fitting method is usually determined based on ____ .

A. economical machining accuracy
B. mean accuracy of component links
C. the highest accuracy which can be obtained in part machining
D. closing links

修配法通常按____确定零件公差。

A. 经济加工精度 B. 组成环平均精度
C. 零件加工可能达到的最高精度 D. 封闭环

18. The organizational forms in assembly process depends mainly on ____.

A. weight of product B. product quality
C. product cost D. production scale

装配的组织形式主要取决于____。

A. 产品重量 B. 产品质量
C. 产品成本 D. 生产规模

6.4 True or false 判断题

1. Workpiece is the least assembly cell in the assembling process of mechanical products. ( )

零件是机械产品装配过程中最小的装配单元。( )

2. Combined member is the non-detachable part in the machine assembling process. ( )

合件在机器装配过程中不可拆卸。( )

3. The quality of fit has to do only with the accuracy of workpiece involved in assembly. ( )

配合精度仅与参与装配的零件精度有关。( )

4. The linear assembly dimensional chain has only one closing link. ( )

直线装配尺寸链只有一个封闭环。( )

5. Stationary adjusting assembly method is used to achieve the assembly accuracy by means of replacing the regulating members with different sizes. ( )

采用固定调节法是通过更换不同尺寸的调节件来达到装配精度。( )

6. In finding assembly dimensional chain, a related part may have two dimensions as component links listed in the assembly dimensional chain. ( )

在查找装配尺寸链时，一个相关零件有时可有两个尺寸作为组成环列入装配尺寸链。( )

7. Generally, the extremum method is used for calculating assembly dimensional chain in the case of high assembly accuracy and more component links. ( )

一般在装配精度要求较高，而环数又较多的情况下，应用极值法来计算装配尺寸链。( )

8. Individual fitting method is chiefly used for the components with more component links and higher assembly accuracy in job and batch production. ( )

修配法主要用于单件、成批生产中装配组成环较多而装配精度又要求比较高的部件。

9. The difference between the adjusting assembly method and the individual fitting method lies in that the former achieves assembly accuracy through changing the position of compensating part or replacing compensating part instead of removing the metal from workpiece. ( )

调整装配法与修配法的区别是调整装配法不是靠去除金属，而是靠改变补偿件的位置或更换补偿件的方法来保证装配精度的。( )

10. The tolerance of coordination link should be determined according to the assembly accuracy. 协调环应根据装配精度指标确定其公差。( )

6.5 Short-answer questions 简答题

1. What contents does the assembly accuracy include? What are the factors influencing on assembly accuracy?

装配精度包括哪些内容？影响装配精度的因素有哪些？

2. State briefly the relation between the part accuracy and assembly accuracy.

简要说明零件精度与装配精度之间的关系。

3. What assembly methods are there to ensure assembly accuracy? What characteristics do the assembly methods have?

保证装配精度的方法有哪些？各有何特点？

4. How to select the assembly method?
如何选择装配方法?

5. What are the difference between assembly dimensional chain and process dimensional chain?
装配尺寸链和工艺尺寸链有何区别?

6. State the methods, procedures and rules to establish assembly dimensional chain.
试说明建立装配尺寸链的方法、步骤和原则。

7. What attentions should be paid in finding assembly dimensional chain?
查找装配尺寸链应注意哪些问题?

8. What is the difference in the solution of dimensional chain between the extremum method and the probability method? What cases are they used in?
极值法解尺寸链与概率法解尺寸链有何不同? 各用于何种情况?

9. What is the individual fitting method? What conditions does it suit? What are the principles in the selection of fitting link when the individual fitting method is used to achieve the assembly accuracy? When the nature of fitting link in the assembly dimensional chain is changed, i. e. increasing link or decreasing link, whether the fomulate to calculate the dimension of fitting link are the same? Why?
何谓修配法? 其适用的条件是什么? 采用修配法获得装配精度时, 选取修配环的原则是什么? 当修配环在装配尺寸链中所处的性质 (指增环或减环) 改变时, 计算修配环尺寸的公式是否相同? 为什么?

10. What is the grouping assembly method? What conditions does it suit? If the tolerances of mating parts are not equal, what consequence would the grouping assembly method produce?

何谓分组装配法？其适用的条件是什么？如果相配合工件的公差不等，采用分组互换法将产生什么后果？

11. What is the adjusting assembly method? What are the advantages and disadvantages of movable adjusting method, stationary adjusting method and error counteraction adjusting method?

何谓调整法？可动调整法、固定调整法和误差抵消调整法各有什么优缺点？

12. What are the principles and contents in drawing up the assembly process?

制订装配工艺规程的原则和内容包括哪些？

13. What kinds do the assembly organization forms have? What occasions are they suitable for?

装配的组织形式有哪几种？各适用于什么场合？

14. Why do we divide assembly unit? How do you plot the assembling system chart?

为什么要划分装配单元？如何绘制装配工艺系统图？

6.6 Analysis and calculation 分析与计算题

1. To draw up respectively the assembly dimensional chains of 3 assembly drawings shown in Fig. 6-1.

画出图 6-1 所示三个装配图的装配尺寸链。

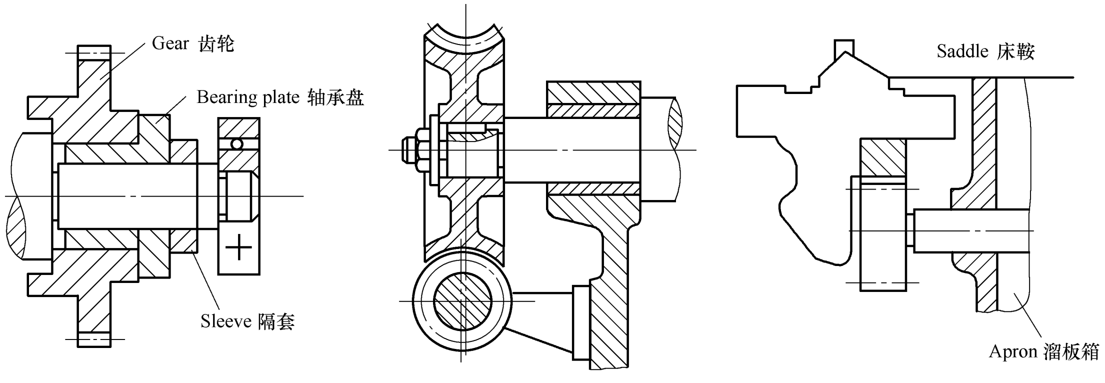


Fig. 6-1 To establish assembly dimension chains 建立装配尺寸链

2. An assembly dimensional chain is shown as Fig. 6-2. Suppose each component link has the same tolerance, try to calculate separately the tolerance of each component link by means of extremum method and probability method, and to determine the upper and lower deviation of each component link.

图 6-2 所示为装配尺寸链。假定每一个组成环的公差相等，试分别采用极值法和概率法求解每个组成环的公差，并确定各自的上、下极限偏差。

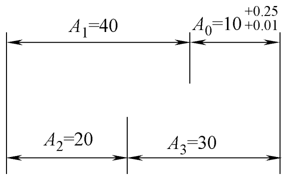


Fig. 6-2 An assembly dimension chain 装配尺寸链

3. Fig. 6-3 shows the assembling sketch of carriage and guideway. It is required to ensure the assembly clearance $A_0 = 0 \sim 0.6$mm. It is determined to adopt individual fitting method to ensure assembly accuracy and to choose the pressing plate as fitting link. Given that $A_1 = 30^{\ 0}_{-0.15}$mm, $A_2 = 20^{+0.25}_{\ 0}$mm, $T_{A_3} = 0.10$mm.

1) When fitting surface M, suppose the minimum fitting allowance $Z_{min} = 0.1$mm, try to find A_3 and its deviation and the maximum fitting allowance Z_{max}.

2) When fitting surface P, suppose the minimum fitting allowance $Z_{min} = 0.1$mm, try to find A_3 and its deviation and the maximum fitting allowance Z_{max}.

图 6-3 所示为机床溜板与导轨装配简图，要求保证间隙 $A_0 = 0 \sim 0.6$mm。现采用修配法来保证装配精度，选择压板为修配环。已知：$A_1 = 30^{\ 0}_{-0.15}$ mm，$A_2 = 20^{+0.25}_{\ 0}$ mm，$T_{A_3} = 0.10$mm。

1）试求在最小修配量 $Z_{min} = 0.1$mm 情况下，修配 M 面时 A_3 的尺寸及其极限偏差，并计算最大修配量 Z_{max}。

2）试求在最小修配量 $Z_{min} = 0.1$mm 情况下，修配 P 面时 A_3 的尺寸及其极限偏差，并计算最大修配量 Z_{max}。

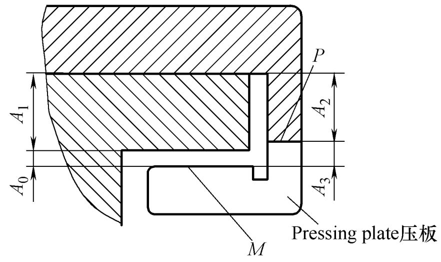


Fig. 6-3 Assembling sketch of carriage and guide ways
机床溜板和导轨的装配简图

4. Fig. 6-4 shows the flange assembling sketch of the lathe CA6140 spindle. According to the assembling requirement, the space between the flange of spindle nose and the end face of headstock should be kept in the range of 0.38 ~ 0.95mm. Try to find the dimensions of related parts influencing on assembly accuracy and their upper and lower deviations.

图 6-4 所示为 CA6140 型车床主轴法兰盘装配简图。根据装配要求，主轴前端法兰盘与床头箱端面间保持间隙在 0.38～0.95mm。试查明影响装配精度的有关零件上的尺寸，并求出有关尺寸的上、下极限偏差。

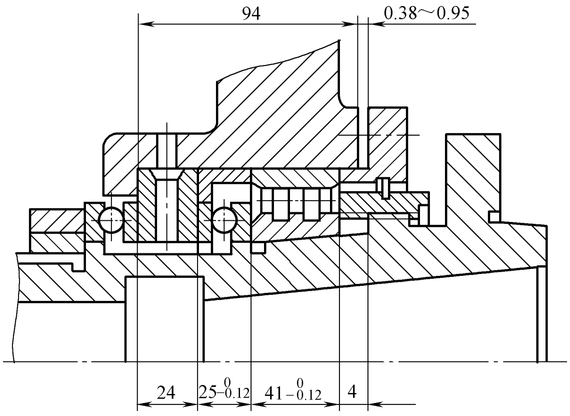


Fig. 6-4 Assembling sketch of the flange on the spindle
主轴法兰盘装配简图

5. Fig. 6-5 shows a gearbox assembly. According to the service performance, the axial gap between the shoulder of gear shaft and the end face of bearing sleeve should be kept in the range of 1 ~ 1.75mm. Given that $A_1 = 101$mm, $A_2 = 50$mm, $A_3 = A_5 = 5$mm, $A_4 = 140$mm, try to find the tolerances and deviations of these dimensions.

图 6-5 所示为一齿轮箱部件。根据使用性能，要求齿轮轴轴肩与支承套端面之间的间隙为 1～1.75mm。已知：$A_1 = 101$mm，$A_2 = 50$mm，$A_3 = A_5 = 5$mm，$A_4 = 140$mm，试求这些尺寸的公差和偏差。

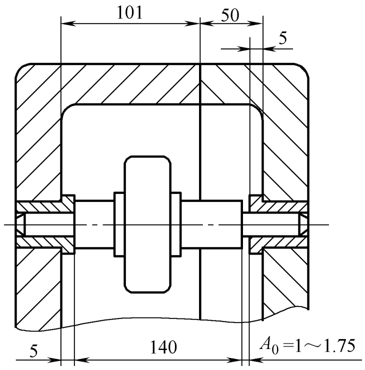


Fig. 6-5 Gearbox assembly 齿轮箱部件

6. As shown in Fig. 6-6, in order to insert the spring washer into between gear and shaft shoulder easily, the axial gap $A_0 = 0.05 \sim 0.42$mm should be ensured. Given that $A_1 = 32.5$mm, $A_2 = 35$mm, $A_3 = 2.5$mm, try to find respectively the deviation of each component link by means of extremum method and probability method.

图6-6所示为轴与齿轮的装配件，为保证弹性挡圈的顺利装入，要求保证轴向间隙0.05~0.41mm。已知各组成环的基本尺寸 $A_1 = 32.5$mm，$A_2 = 35$mm，$A_3 = 2.5$mm。试用极值法和概率法分别确定各组成零件的偏差。

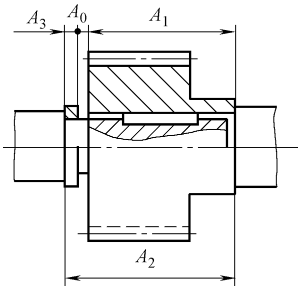


Fig. 6-6 Assembly of shaft and gear
轴与齿轮的装配

7. The assembly relation between the headstock and the tailstock of lathe is shown in Fig. 6-7. After assembled, $A_0 = 0^{+0.06}_{0}$mm should be ensured. Given that $A_1 = (202 \pm 0.05)$mm, $A_3 = (156 \pm 0.05)$ mm, $TA_2 = 0.15$mm. Suppose individual fitting assembly method is used, and A_3 is selected to be the fitting link. In order to ensure the assembly accuracy $A_0 = 0^{+0.06}_{0}$mm, find the deviation distribution of A_2 (esA_2, eiA_2). Suppose the minimum fitting allowance $Z_{min} = 0.1$mm, try to find the maximum fitting allowance Z_{max}.

图6-7所示为车床主轴箱与尾座装配关系图。要求装配后保证尾座中心与主轴箱中心的距离 $A_0 = 0^{+0.06}_{0}$mm。已知 $A_1 = (202 \pm 0.05)$ mm，$A_3 = (156 \pm 0.05)$mm，$TA_2 = 0.15$mm。现采用修配法装配，选择 A_3 为修配环。为保证装配要求 $A_0 = 0^{+0.06}_{0}$mm，试求 A_2 及其偏差。假设最

小修配量 Z_{min} = 0.1mm，试求最大修配量 Z_{max}。

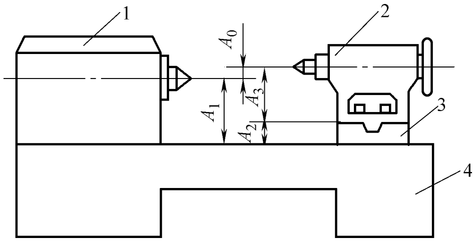


Fig. 6-7 Assembly relation between the headstock and the tailstock of lathe 车床主轴箱与尾座装配关系图

1—Headstock 主轴箱 2—Tailstock 尾座 3—Baseplate 底板 4—Bed 床身

8. Fig. 6-8 shows a structural sketch of dual-rotor pump. After assembling, the assembly clearance A_0 = 0.05 ~ 0.15mm should be ensured under cold conditions. The nominal dimensions of component links are as follows: A_1 = 41mm, A_2 = A_4 = 17mm, A_3 = 7mm. Try to find respectively the dimension and its deviation of each component link by means of completely interchangeable assembly method and probability method (A_1 is chosen to be the coordination link).

图 6-8 所示为双联转子泵结构简图。要求冷态下的装配间隙 A_0 = 0.05 ~ 0.15mm。各组成环的基本尺寸为：A_1 = 41mm，A_2 = A_4 = 17mm，A_3 = 7mm。试分别用完全互换法和概率法求解各组成环的尺寸及其偏差（选 A_1 为协调环）。

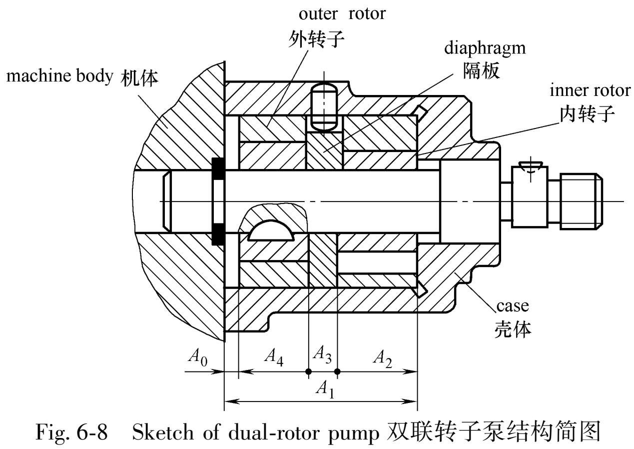


Fig. 6-8 Sketch of dual-rotor pump 双联转子泵结构简图

9. The fit of a shaft and a hole is $\phi 50H_3/h_3$. In order to reduce machining cost, it is determined to machine the shaft and the hole in light of IT7. Try to calculate the following items by means of grouping assembly method:

(1) Numbers of group and the limit deviation of each group.

(2) Suppose 10000 sets are to be machined, and the diameters of both the hole and the shaft obey the normal distribution, then how many the holes and the shafts are there in each group?

某轴与孔的尺寸和公差配合为 $\phi 50H_3/h_3$。为降低加工成本，现将两零件按 IT7 公差制造，试用分组装配法计算：

（1）分组数和每一组的极限偏差。

（2）若加工 1 万套，且孔径和轴径的实际分布都服从正态分布，每一组孔与轴的零件数各为多少？

10. Fig. 6-9 shows a sketch of boring fixture. It is required that the distance between location surface to the axis of hole is $A_0=(155\pm0.015)$ mm. As this is a job and small volume production, individual fitting method is used to ensure the assembly accuracy, and the location board $A_1=20$mm is selected as fitting workpiece. Based on the production condition, the appropriate maximum fitting allowance of location plate is not larger than 0.3mm. Try to calculate the dimension and its deviation of each component link.

图 6-9 所示为镗孔夹具简图。要求定位面到孔轴线的距离 $A_0=(155\pm0.015)$ mm。单件小批生产用修配法保证该装配精度，并选取定位板 $A_1=20$mm 为修配件。根据生产条件，在定位板上最大修配量以不超过 0.3mm 为宜。试确定各组成环的尺寸及其偏差。

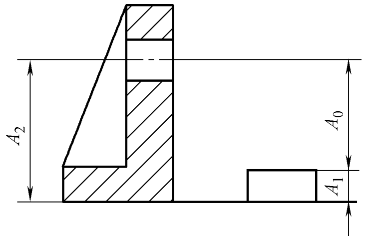


Fig. 6-9　Sketch of a boring fixture
镗孔夹具简图

11. Fig. 6-10 shows the assembly drawing of a sleeve in the tailstock of lathe. Try to calculate the end face runout of the nut in the sleeve of lathe center by means of completely interchangeable assembly method and probability method respectively.

车床尾座套筒装配图如图 6-10 所示。试分别按完全互换法和概率法计算螺母在顶尖套筒内的轴向圆跳动误差。

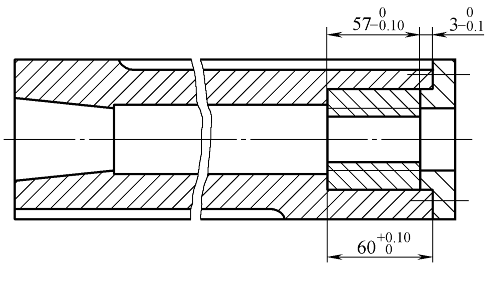


Fig. 6-10　Assembly drawing of a sleeve in the tailstock of lathe 车床尾座套筒装配图

12. There is a piston assembly, as shown in Fig. 6-11. The dimension of each relevant component is indicated on the piston assembly drawing. Try to calculate the limit dimension of piston stroke by means of extremum method and probability method respectively.

一活塞部件的各组成零件有关尺寸如图 6-11 所示，试分别用极值法和概率法计算活塞

行程的极限尺寸。

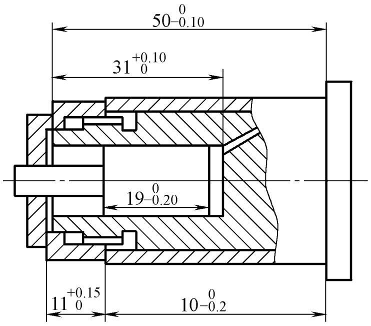


Fig. 6-11 Assembly drawing of a piston assembly 活塞部件装配图

13. Fig. 6-12 shows the assembly sketch of a speed reducer. The dimensions of the workpieces mounted on the shaft are as follows: $A_1=40$mm, $A_2=36$mm, $A_3=4$mm. The axial clearance $A_0=$ 0. 10~0. 25mm have to be ensured. Try to determine the tolerances and deviations of A_1, A_2, A_3 by means of extremum method and probability method respectively.

图 6-12 所示减速器中某轴上零件的尺寸为 $A_1=40$mm, $A_2=36$mm, $A_3=4$mm。要求装配后齿轮轴向间隙 $A_0=0.10$~0.25mm。试用极值法和概率法分别确定 A_1、A_2、A_3 的公差及偏差。

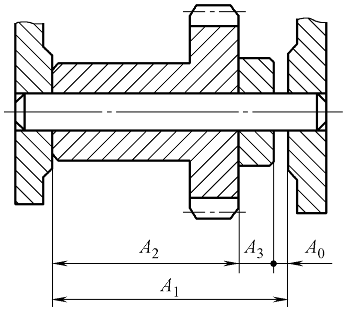


Fig. 6-12 Assembly drawing of a speed reducer 减速器部件装配图

14. As shown in Fig. 6-13. The axial clearance between the gear and the washer should be kept in 0. 1-0. 35mm. Given that $A_1=30$mm, $A_2=5$mm, $A_3=43$mm, $A_4=3^{\ 0}_{-0.05}$mm (standard part), $A_5=5$mm. When the following assembly methods are used, try to determine the tolerance and the limit deviation of every component link respectively.

(1) Completely interchangeable assembly method.

(2) Partial interchangeable assembly method.

(3) Individual fitting assembly method (select A_5 to be fitting link).

(4) Adjusting assembly method (select A_5 to be adjusting part).

图 6-13 所示为齿轮装配，轴固定，而齿轮空套在轴上回转，要求保证齿轮与挡圈的轴向间隙为 0. 1~0. 35mm，已知：$A_1=30$mm、$A_2=5$mm、$A_3=43$mm、$A_4=3^{\ 0}_{-0.05}$mm（标准件）、

A_5 = 5mm，当采用下列装配方法时，试确定各组成环的公差和极限偏差。

（1）完全互换装配法。

（2）不完全互换装配法。

（3）修配装配法。

（4）调整装配法。

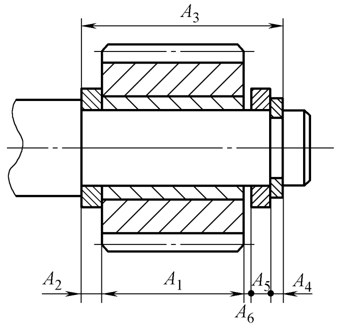


Fig. 6-13 Assembly of shaft and gear
轴与齿轮的装配

15. Fig. 6-14 shows the assembly sketch of a key and a keyway. Given that A_1 = 20mm, A_2 = 20mm, the space A_0 = 0.05 ~ 0.15mm should be ensured after assembling.

(1) If the completely interchangeable assembly method is used in large volume production, try to find the dimension and deviations of each component link.

(2) In small volume production, take $A_2 = 200^{+0.13}_{0}$ mm, T_1 = 0.052mm. If the individual fitting method is used, try to select the fitting part and find the dimension and deviations of the fitting part, and calculate the max. fitting allowance when the least fitting allowance is zero.

(3) When the least fitting allowance is F_{min} = 0.05mm, try to find the dimension, deviations of the fitting part and the max. fitting allowance.

图 6-14 所示为键槽与键的装配简图。已知 A_1 = 20mm，A_2 = 20mm，装配后保证间隙 A_0 = 0.05 ~ 0.15mm。

（1）当大批生产时，采用完全互换法装配，试求各组成零件尺寸的上、下极限偏差。

（2）当小批量生产时，$A_2 = 20^{+0.13}_{0}$ mm，T_1 = 0.052mm。采用修配法装配，试选择修配件；并计算在最小修配量为零时，修配件的尺寸和偏差及最大修配量。

（3）当最小修配量 F_{min} = 0.05mm 时，试确定修配件的尺寸和偏差及最大修配量。

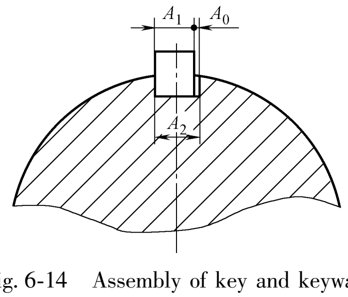


Fig. 6-14 Assembly of key and keyway
键槽与键的装配

16. Fig. 6-15 shows the local assembly sketch of a gear mechanism. It is required after assembling that the axial clearance between the right end face of shaft and the end face of right bearing be kept in the range of 0. 05~0. 25mm. Try to calculate the dimension and deviations of each component link by means of extremum method and probability method respectively, and compare the results obtained by two methods.

图 6-15 所示为某一齿轮机构的局部装配图。装配后要求保证轴右端与右端轴承端面之间的间隙在 0. 05~0. 25mm 内。试用极值法和概率法计算各组成环的尺寸公差及上、下极限偏差，并比较两种方法的结果。

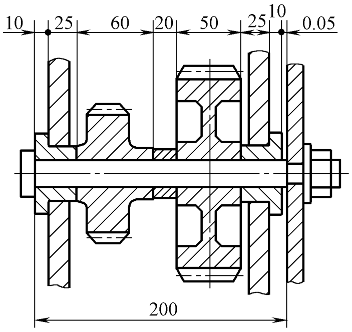


Fig. 6-15 Assembly sketch of a gear mechanism 齿轮机构的装配简图

17. Fig. 6-16 shows the drilling jig sketch of a horizontal modular machine tool. Assembly requires that the distance from location surface to the axis of drilling bush is (110±0. 03) mm. It is determined to use individual fitting method to solve the assembly dimensional chain, and to select the location plate as fitting part, take A_3 = 12mm, T_3 = 0. 02mm. Given that A_2 = 20mm, T_2 = 0. 08mm, A_1 = (150±0. 05) mm, the coaxiality between the inner surface and outer surface of drilling bush is ϕ0.02mm. According to the production requirement, the least fitting allowance is 0. 1mm, the max. fitting allowance can' t be larger than 0. 3mm, try to determine the the dimension and deviations of fitting part and the deviations of A_2.

图 6-16 所示为某卧式组合机床的钻模简图。装配要求定位面到钻套轴线的距离为(110±0. 03) mm。现用修配法来解此装配尺寸链，选取修配件为定位支承板，A_3 = 12mm，T_3 = 0. 02mm。已知：A_2 = 20mm，T_2 = 0. 08mm，A_1 = (150±0. 05) mm，钻套内孔与外圆同轴度误差为 ϕ0.02mm。根据生产要求定位板上的最小修磨量为 0. 1mm，最大修磨量不得超过 0. 3mm。试确定修配件的尺寸和偏差以及 A_2 的偏差。

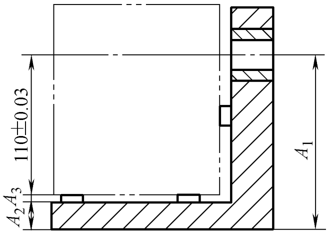


Fig. 6-16 Drilling jig 钻模

Chapter 7

Brief Introduction to Advanced Manufacturing Technology

第 7 章

先进制造技术简介

7.1 English-Chinese Terms 名词英汉对照

1. manufacturing technology 制造技术
2. advanced manufacturing technology 先进制造技术
3. ultra-precision machining 超精密加工
4. ultra-precision cutting 超精密切削
5. mirror grinding 镜面磨削
6. micro machining 微细加工
7. lithography machining 光刻加工
8. nano machining 纳米加工
9. high-speed machining 高速加工
10. motorized spindle 电主轴
11. non-traditional machining 特种加工
12. ultrasonic Machining 超声波加工
13. laser beam machining 激光加工
14. rapid prototyping and manufacturing 快速原型制造
15. stereo lithography 立体光刻
16. selective laser sintering 选择性激光烧结
17. fused deposition modeling 熔融沉积成形
18. laminated object manufacturing 分层实体制造
19. three dimensional printing 三维打印
20. concurrent engineering 并行工程
21. lean production 精益生产
22. agile manufacturing 敏捷制造

7.2 Filling in the blanks 填空题

1. According to the adding or subtracting of material in machining process, Precision machining and ultra-precision machining methods can be classified as ________、additive machining and ________ .

根据加工过程中材料重量的增减，精密与超精密加工方法可分为________、增材加工和________。

2. The cutting tool materials used usually in high speed cutting tool are ________, ceramics, CBN and ________ .

高速切削通常使用的刀具材料是________、陶瓷、CBN 和________。

3. The layout forms of machine tools in are ________________, ____________________ mixed type and so on.

FMS 中机床设备的配置有________、________和混合式等多种形式。

4. Three supports of lean production are ________, ________ and total quality management.
精益生产的三根支柱是________、________和全面质量管理。

5. The concept of advanced manufacturing technology is proposed by ________ in ________.
先进制造技术这一概念是由________于________年代提出来的。

6. A flexible manufacturing system is composed of ________, material handling , ________ and computer control system.
柔性制造系统是由________、物料运输系统、________、一套计算机控制系统组成。

7. Ultra-precision cutting belongs to micro-cutting, its cutting mechanism is that the cutting is carried out in ________ at quite high cutting speed; its cutting force is larger than the binding force of ________, but the heat produced in cutting is lass and the deformation of workpiece is very small.
超精密车削属于微量切削，其切削机理是切削以很高的切削速度在________内进行，切削力大于________的结合力，产生的切削热少、工件变形小。

8. The sharpening technologies of ultra-precision cutting tool include ________, cutting edge sharpening technology and ________.
超精密刀具刃磨技术包括________、刃口刃磨工艺和________。

9. The characteristics of concurrent engineering are ________, ________, cooperative characteristic and integration characteristic.
并行工程的特性是________、________、协同特性和集成特性。

10. Ultrasonic machining equipment consists of high-frequence power source, ________, machine tool and ________.
超声波加工装置包括高频电源、________、机床和________。

7.3 Making choice 选择题

1. In broad sence, manufacturing can be seen as ____ production.

A. continuous type B. discrete type

C. intermittent type D. intensive type

广义上讲，制造可以视为____生产。

A. 连续型 离散型 C. 间歇型 集约型

2. Lean production is a kind of description of ____ production mode.

A. Boeing Co B. GM Co

C. Mitsubishi Co D. Toyota Co

精益生产是对____生产模式的描述。

A. 波音公司 B. 通用公司

C. 三菱公司 D. 丰田公司

3. Concurrent engineering is systematic working mode to design the product and its ____ in parallel and integration.

A. workpiece B. equipment

C. technological equipment　　D. related process

并行工程是对产品及____进行并行、一体化设计的一种系统化的工作模式。

A. 零件　B. 设备　C. 工艺装备　D. 相关过程

4. The companies implementing concurrent engineering often use ____ type of organization.

A. linear　B. functional　C. matrix　D. freedom

实行并行工程的企业多采用____的组织形式。

A. 直线式　B. 职能式　C. 矩阵式　D. 自由式

5. Under the changeable market environment, ____ will become more and more important in several factors influencing on competitiveness.

A. time　B. quality　C. cost　D. service

在多变的市场环境下，影响竞争力的诸要素中____将变得越来越突出。

A. 时间　B. 质量　C. 成本　D. 服务

6. FMS is especially suitable for ____ production.

A. job　　B. many varieties, small and middle volume

C. large volume　　D. less variety, small and middle volume

柔性制造系统（FMS）特别适合于____生产。

A. 单件　　B. 多品种、中小批量

C. 大批量　　D. 少品种、中小批量

7. Advanced manufacturing technology is firstly proposed by America in ____ 20 century.

A. the middle of 1970's　　B. the early of 1980's

C. the end of 1980's　　D. the middle of 1990's

先进制造技术首先由美国于 20 世纪____提出。

A. 70 年代中　B. 80 年代初　C. 80 年代末　D. 90 年代中

8. AMT is a complete group of technology produced by combining manufacturing technology with ____ .

A. modern management science　　B. modern high technology

C. computer technology　　D. measurement and control technology

AMT 是制造技术和____结合而产生的一个完整的技术群。

A. 现代管理科学　　B. 现代高技术

C. 计算机技术　　D. 测控技术

9. Currently, the machining accuracy which can be obtained by precision machining is ____ .

A. 1～10μm　B. 0.1～1μm　C. 0.01～0.1μm　D. 0.001～0.01μm

当前精密加工所达到的精度是____。

A. 1～10μm　B. 0.1～1μm　C. 0.01～0.1μm　D. 0.001～0.01μm

10. The most common used cutting tool material in ultra-precision cutting is ____ .

A. high speed steel　　B. carbide alloy

C. ceramics　　D. diamond

在超精密切削加工中，最常用的刀具材料是____。

A. 高速钢　B. 硬质合金　C. 陶瓷　D. 金刚石

11. The purpose of dressing the diamond wheel or CBN wheel is to make the abrasive grains ____.

A. change flat B. change fine

C. change sharp D. change prominency

金刚石或 CBN 砂轮修锐的目的是使磨粒____。

A. 平整 B. 变细 C. 变尖 D. 突出

12. Lithography machining is mainly used to ____.

A. machine super-hard materials B. machine engineering ceramics

C. make integrated circuits D. make micro moulds

光刻加工主要用于____。

A. 加工超硬材料 B. 加工工程陶瓷

C. 制作集成电路 D. 制作微型模具

13. In order to ensure the machining quality of a hole, laser beam machining requires the machining surface ____.

A. locate in between the focus and lens

B. consistent with the position of focus

C. locate outside the focus

D. which is the focal distance far from the focus

激光打孔时，为保证加工孔的质量，要求加工面____。

A. 位于焦点和透镜之间 B. 与焦点位置一致

C. 位于焦点之外 D. 距焦点距离等于焦距

14. The electron beam is especially suitable for machining semi-conductor materials, the primary reason is that electron beam machining ____.

A. has high machining efficicney B. has small workpiece deformation

C. is performed under the vaccum condition D. has good controllability

电子束特别适合于加工半导体材料，其主要原因是电子束加工____。

A. 加工效率高 B. 工件变形小

C. 在真空条件下进行 D. 可控性好

15. The function of amplitude transformer in ultrasonic machining equipment is to ____.

A. magnify vibration amplitude B. decrease vibration amplitude

C. change vibration direction D. change vibration frequence

超声波加工设备中变幅杆的功能是____。

A. 增大振动幅值 B. 减小振动幅值

C. 改变振动方向 D. 改变振动频率

7.4 True or false 判断题

1. Advanced manufacturing technology is the offspring produced by combining traditional manufacturing technology with high technology. ( )

先进制造技术是传统机械制造技术与高新技术相结合的产物。(　　)

2. Flexible manufacturing system is run in light of fixed production cycle time. (　　)

柔性制造系统按固定的生产节拍运行。(　　)

3. It is improper for the small and medium-sized company to use advanced manufacturing technology. (　　)

中小企业不宜采用先进制造技术。(　　)

4. It is required that the infrastructure of manufacturing technology should use the most advanced equipment and tools. (　　)

制造技术基础设施要求采用最先进的设备和工具。(　　)

5. AMT is the technology facing to 21st century. (　　)

AMT 是面向 21 世纪的技术。(　　)

6. Precision machining is also called nanostmachining. (　　)

精密加工又称为纳米加工。(　　)

7. Ductile grinding means the finish grinding performed on the workpieces made of ductile materials. (　　)

塑性磨削是指对塑性材料零件进行的精磨加工。(　　)

8. Abrasive belt polishing can be used in the ultraprecision polishing of mould cavity and other complex surfaces. (　　)

砂带抛光可用于模具型腔等复杂曲面的超精抛光加工。(　　)

9. In micromachining, the machining accuracy is represented by the absolute value of error size. (　　)

在微细加工时用误差尺寸的绝对值来表示加工精度。(　　)

10. The cutting mechanism of micromachining is the same as that of conventional machining. (　　)

微细加工与常规加工切削机理相同。(　　)

11. Laser welding can be used in the welding of metal and nonmetal. (　　)

激光焊接可以用于金属和非金属之间的焊接。(　　)

12. The electron beam machining can be done in atmosphere. (　　)

电子束加工可以在大气中进行。(　　)

13. Using the ultrasonic combined machining can remarkably improve machining efficiency. (　　)

采用超声复合加工可显著提高加工效率。(　　)

14. The implement of concurrent engineering must have the communications infrastructure composed of computers, network, and database. (　　)

实施并行工程必须具备由计算机、网络、数据库等组成的通信基础设施。(　　)

15. CIM emphasizes the information integration and share, and CE stresses on the integration of product design and related process design. (　　)

CIM 着重信息集成与信息共享,CE 则强调产品设计及其相关过程设计的集成。(　　)

16. Agile manufacturing can implement only in the major company with tremendous strength. (　　)

敏捷制造只能在实力雄厚的大公司实施。( )

17. Virtual enterprise means the enterprise which uses the virtual manufacturing technology. ( )

虚拟企业是指已采用虚拟制造技术的企业。( )

18. Advanced manufacturing technology mainly seeks high technology. ( )

先进制造技术主要追求技术高新。( )

19. High speed machining means the machining technology whose spindle revolution has exceeded a set value. ( )

高速加工是指主轴转速超过某一设定值后的加工技术。( )

20. Concurrent engineering is to convert the successive activities in time into the one which are considered simultaneously and handled simultaneously and concurrently as far as possible. ( )

并行工程是把时间上有先后的作业活动转变为同时考虑和尽可能同时处理和并行处理的活动。( )

7.5 Short-answer questions 简答题

1. What are the characteristics of advanced manufacturing technology?

先进制造技术有何特点?

2. What are the requirements of ultra-precision machining for the machine tools and working environment?

超精密加工对机床设备和环境有何要求?

3. What are the key technologies to carry out high speed machining?

实现高速切削加工的关键技术有哪些?

4. What methods does the unconventional machining chiefly include? What characteristic does each method have? What occasion does each method suit?

特种加工主要包括哪些方法?各有何特点?各适用于什么场合?

5. What is the operation principle of RPM? What are its characteristics? What occasion does it suit?

快速原型制造(RPM)的原理是什么?有何特点?适用于什么场合?

6. What are the micromachining methods?
目前有哪些微细加工方法?

7. What is the nano machining technology?
何谓纳米加工技术?

8. State briefly the operation principle of stereo lithography.
简述立体光刻技术的工作原理。

9. State briefly the operation principle of selective laser sintering.
简述选择性激光烧结的工作原理。

10. State briefly the operation principle of laminated object manufacturing.
简述分层实体制造的工作原理。

11. State briefly the operation principle of fused deposition modeling.
简述熔融沉积成形的工作原理。

12. What are the FMS composed of? State briefly the applications of FMS.
柔性制造系统（FMS）由哪几部分组成?简述柔性制造系统的适用范围。

13. State briefly the concept and its constitution CIMS.
简述集成制造系统（CIMS）的概念及构成。

14. State briefly the operation principle of RPM.
简述快速原型制造（RPM）原理。

15. State briefly the background of the emerging of AM.

简述敏捷制造（AM）产生的背景。

16. State briefly the background of the emerging of LP.
简述精益生产（LP）的产生背景。

17. State briefly the concept of CAM.
简述计算机辅助制造（CAM）的概念。

18. What is the IMS? What are the similarities and differences between IMS and CIMS?
何谓智能制造系统（IMS）？IMS 与 CIMS 有何异同？

19. What are the characteristics of LP?
精益生产（LP）有何特征？

20. State briefly the characteristics of precision and ultra-precision grinding with superhard grinding wheel.
简述超硬磨料砂轮精密与超精密磨削的特点。

21. What are the requirements of dry cutting for cutting tools?
干式切削对切削刀具有哪些要求？

7.6 Analysis of questions 分析题

1. Why does our country implement advanced manufacturing technology (AMT)? How to implement it?
我国为什么要发展先进制造技术？应如何发展？

2. Why do we develop high speed cutting technology? State briefly some key technologies of high speed machine tool.
为什么要发展高速切削技术？简述高速切削机床的一些关键技术。

3. State briefly the implication of dry cutting. What technological measures should be taken in order to carry out dry cutting?

简述干式切削的含义。实施干式切削技术应采用哪些工艺措施?

4. Narrate the characteristics of flexible manufacturing system (FMS). Analyze the functional requirements of machining system and the characteristics of machine tool layout in FMS.

叙述柔性制造系统的特征，分析柔性制造系统的加工系统功能要求和机床配置形式的特点。

5. Why do most of ordinary machining use cutting fluid? What problems would the use of cutting fluid cause? Under the condition of dry cutting, how to produce the cutting condition which is the same as or similar to the wet cutting?

为什么普通加工大都使用切削液?使用切削液会带来什么问题?如何在没有切削液的情况下创造与湿式切削相同或相近的切削条件?

6. How do you think what is the developing trend of domestic manufacturing engineering?

你认为我国制造工程学科发展的趋势是什么?

7. Why do we say that our country has become the "big country in manufacturing" but not the "powerful country in manufacturing"?

为什么说我国已成为“制造大国”但还不是“制造强国”?

8. Now that flexible manufacturing system is a automated manufacturing system controlled by compute, why do we say that the "human" still plays the important roles? List the roles played by people in FMS.

既然柔性制造系统是一个由计算机控制的自动化制造系统，为什么说“人”仍起着重要作用?列出人在柔性制造系统中所扮演的角色。

9. Compared with the marks of "powerful country in manufacturing", talk about what problems do you think of "Made in China".

对比“制造强国”的标志，谈谈你认为“中国制造”存在哪些问题。

Appendix

附　录

Ⅰ. Evaluation exercises 自测练习

一、填空题（Filling in the blanks）

1. Four types of chips are ____, cracked chips, ____, splintering chips.

2. The functions of lathe headstock are ____ and ____.

3. Three types of spindle revolving errors are ____, pure axial runout, ____.

4. Generally, the process route of a workpiece is divided into three machining phases, i. e. rough machining phase, ____, ____.

5. $\overline{X}$ chart reflects the changing trend of ____, R chart reflects the changing trend of ________.

二、单项选择题（Making choice）

1. A shaft is machined by means of a lathe and a grinding machine. The process should be divided into ____.

A. two operations　　B. two working steps
C. two working positions　　D. one compound working step

2. The number of feed motion in cylindrical grinding may be ____.

A. only one　　B. two　　C. three　　D. four

3. The carbides often used to cut brittle materials belong to ____.

A. YT type (P)　　B. YG type (K)　　C. YW type (M)　　D. diamond

4. The element which has the largest effect on cutting force is ____.

A. cutting thickness　　B. cutting depth　　C. feed　　D. cutting speed

5. In surface grinding, the grade and structure of grinding wheel should be ____.

A. soft and dense　　B. soft and open
C. hard and dense　　D. hard and open

6. The gear machining method which is of highest machining accuracy is ____.

A. gear milling　　B. gear shaping
C. gear hobbing　　D. gear grinding

7. There are ____ transmission chains in Y3150E gear hobbing machine.

A. 2　　B. 3　　C. 4　　D. 5

8. In job and small volume production, ____ is often used for the assemblies with many components and higher assembly accuracy.

A. interchangeable assembly method　　B. grouping assembly method
C. adjusting assembly method　　D. individual fitting method

9. Workpiece positioning error belongs to ____.

A. machining principle error　　B. constant systematic error
C. variable systematic error　　D. random error

10. Generally, the heat treatment between rough machining and semi-finishing is ____ .

A. normalizing B. nitriding

C. quenching and tempering D. carburizing

三、简答题（Short-answer questions）

1. Make the drawing of a lathe cutter on P_o plane, and indicate γ_o, α_o; state briefly the principle of choosing γ_o and α_o.

2. What is the principle in the selection of machining variables?

3. What are the applications of distribution curve?

4. What factors should be considered when determining tool life?

四、分析计算题（Analysis and calculation）

1. A batch of shafts are machined between centers on a lathe. After turning, it is found by inspection that there is a kind of form error as shown in Fig-1. Try to analyze and indicate the possible reasons for producing this error.

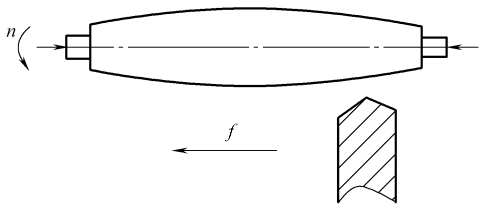


Fig-1

2. Fig-3 illustrates a speed-change gearbox assembly. The axial clearance A_0 should be ensured after the gear is assembled into the gearbox. Try to find out which dimensions would affect A_0, and establish the assembly dimensional chain. Suppose interchangeable assembly method is used, list briefly the procedure to find each dimension and its tolerance.

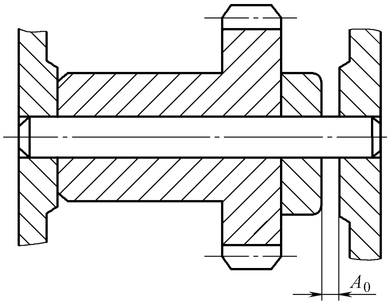


Fig-2

3. A batch of pins with $\phi(12\pm0.01)$ mm in diameter are machined by means of centerless grinding machine. It is found through measuring 100 pins taken from the batch of pins at random that its diameters approach to normal distribution, and the mean value $X=11.99$, the root-mean-square deviation $S=0.003$.

(1) To draw the diameter error distribution curve of pins.

(2) To calculate the process capability coefficient of this operation.

(3) To estimate the reject rate of this operation.

(4) To analyze the reasons for producing rejects and propose solution to eliminating or reducing rejects.

4. A batch of shafts with $\phi20_{-0.01}^{0}$ mm in diameter are machined by means of alathe. Suppose the operational dimensions approach to normal distribution, and standard deviation $\sigma=0.025$mm. The center of tolerance band is located on the left of the center of distribution curve, and the deviation is 0.03mm. Try to calculate the reject rate.

5. A sleeve-type workpiece is shown in Fig-6a. Given that both $38_{-0.1}^{0}$mm and $8_{-0.05}^{0}$mm have been obtained in previous operations. There are three location schemes which can be used for drilling hole, as shown in Fig-6b, c and d respectively. Try to calculate the three operational dimensions A_1, A_2 and A_3 respectively.

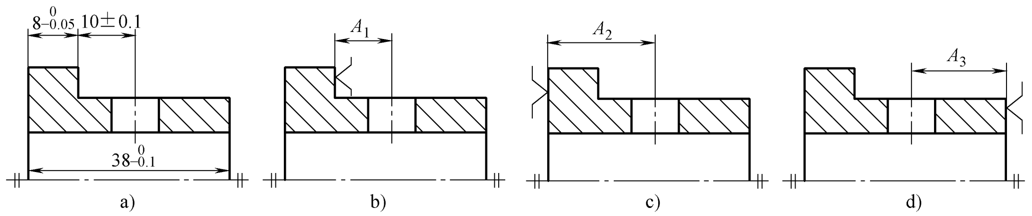


Fig-3

6. A batch of workpieces shown in Fig-8a are located by a V-block on jig to drill two holes with the diameter ϕ5mm and ϕ8mm. Besides ensuring the technical requirements indicated on the workpiece drawing, the symmetry tolerance (0.08mm) of connecting line between two hole centers to the axis of $\phi60^{\ 0}_{-0.1}$mm should also be ensured. There are three location plans to be used, as shown in Fig-8b, c, and d. If the location error must not be larger than 1/2 of operation tolerance, which location plan is feasible? Which is the best plan?

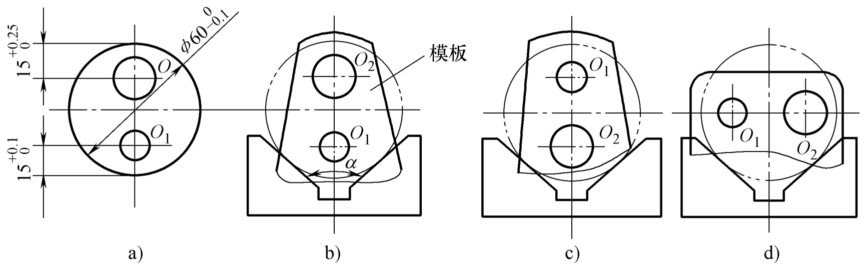


Fig-4

五、判断题（True or false）

1. Of the three cutting variables, the feed has the largest influence on the surface roughness. (　　)

2. The cutters made of diamond can be used to cut ferrous metals like iron and steels. (　　)

3. The lathe cutter with larger κ_r should be selected when turning a long shaft. (　　)

4. The grade of grinding wheel mainly depends on the hardness of abrasive. (　　)

5. Working step is the basic element of process procedure. (　　)

6. The higher the cutting speed, the shorter the tool life. (　　)

7. The partial interchangeable assembly method is only suitable for mass production. (　　)

8. The radial force F_y is larger than the tangential force F_z in cylindrical grinding. (　　)

9. Don't permit the repeat use of rough location datum. (　　)

10. Blank manufacturing errors belong to random errors. (　　)

Ⅱ. Answers to evaluation exercises　自测练习答案

一、填空题（Filling in the blanks）

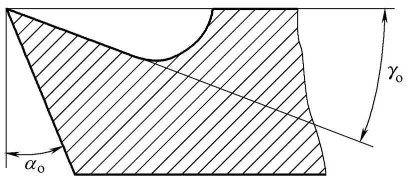
1. ribbon chips, unit chips
2. changing speed (or support), transmitting power
3. radial runout, angular swing
4. semi-finishing phase, finishing phase
5. systematic error, random error

二、单项选择题（Making choice）

1. A　2. B　3. B　4. B　5. B　6. D　7. D　8. D　9. D　10. C

三、简答题（Short-answer questions）

1. choose larger γ_o as far as possible under the precondition of ensuring Tool strength. Choose smaller α_o as far as possible if it would not cause the friction between the flank and the workpiece (Answer Fig-1).



Answer Fig-1

2. Answer: give the prior to select the larger a_p as far as possible; then choose the larger f; lastly, determine the proper v according to tool life and machine power.

3. 1) To determine whether the machining method can ensure the machining accuracy (by comparing T with 6σ).

2) To determine the main factor affecting the machining accuracy is systematic error or random error.

3) To calculate the rejection rate.

4. Answer: it depends on what kind of tool life T is adopted, that is, tool life T_p of the max. productive rate or tool life T_c of the mini. production cost. In practical production, T is usually determined according to T_c. But, under abnormal conditions, T can also be determined based on T_p. Besides, other factors should be considered, such as the complexity of cutting tool, difficulty in tool manufacturing, and what kind of situation is the cutting tool used and so on. For example, the cutting tools with complex structure, or difficulty in resharpening and adjusting, or used on a multi-spindle machine tools should have longer tool life.

四、分析计算题 (Analysis and calculation)

1. Solution: 1) Guide way protrudes to the front side (guide way′s straightness error in horizontal plane.

2) Elastic deformation of slender shaft.

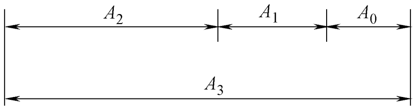
3) Parallelism error of guide ways (twist).

4) Blank error coping.

2. Solution:

Step1: To establish the assembly dimension chain and verify the basic dimension of each link (Answer Fig-2).

1) Closing link: A_0; Increasing link: A_3; Decreasing link: A_1, A_2.



Answer Fig-2

2) $A_0 = A_3 - A_1 - A_2$.

Step2: To determine the tolerance of each component link: $TA_i = \frac{TA_0}{n-1}$, then adjust the tolerance of each component according to the size and machining conditions.

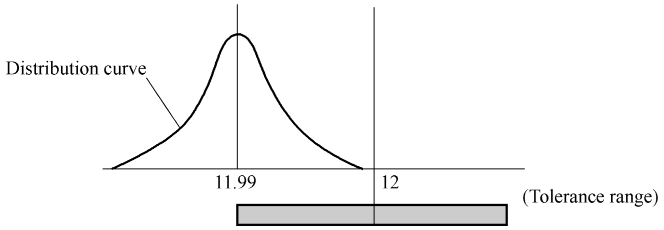
Step3: to determine the limit deviation of component links.

A_1 is determined to be the coordination link, so the limit deviation of other component links can be determined firstly based on the Basic shaft System or Basic hole System. $A_{1\,EI_{A_1}}^{\,ES_{A_1}}$ should be calculated.

Step4: to calculate the ES_{A_1} and EI_{A_1} by means of the formula for calculating dimension chain.

3. Solution:

1) The distribution curve is shown in Answer Fig-3.



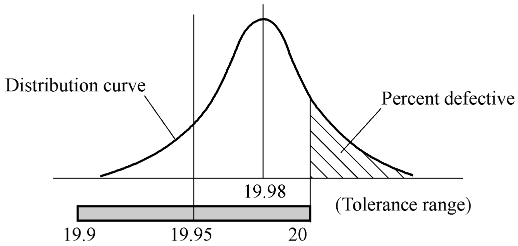
Answer Fig-3

2) The process capability coefficient $C_P = 0.2/(6\times0.003) = 1.1$.

3) The reject rate is about 50%.

4) The primary reasons for producing rejects is that there is a larger constant systematic error. It is probably caused by adjusting the grinding wheel improperly. Therefore, the solution is to reset the position of grinding wheel.

4. Solution : Distribution curve is shown in Answer Fig-4. The reject rate of this operation is about 21.2%.



Answer Fig-4

5. Solution:

1) For Fig-3, we know that $\Delta_{dw} = 0$, so $A_1 = (10\pm0.1)$ mm.

2) For Fig-3c, a dimensional chain is composed of A_2, (10 ± 0.1) mm and $8^{\ 0}_{-0.05}$ mm, where (10 ± 0.1) mm is closing link. By means of the calculation formula for dimensionol chain, there is:

$$10\text{mm} = A_2 - 8\text{mm} \rightarrow A_2 = 18\text{mm}$$

$$0.1\text{mm} = ES_{A_2} - (-0.05\text{mm}) \rightarrow ES_{A_2} = 0.05\text{mm}$$

$$-0.1\text{mm} = EI_{A_2} - 0 \rightarrow EI_{A_2} = -0.10\text{mm}$$

Therefore, $A_2 = 18^{+0.05}_{-0.10}$mm.

3) For Fig-3d, we can calculate A_3 in the similar way.

$$10\text{mm} = 38\text{mm} - (A_3 + 8\text{mm}) \rightarrow A_3 = 28\text{mm}$$

$$0.1\text{mm} = 0 - [EI_{A_3} + (-0.05\text{mm})] \rightarrow EI_{A_3} = -0.05\text{mm}$$

$$-0.1\text{mm} = -0.1\text{mm} - (ES_{A_3} + 0) \rightarrow ES_{A_3} = 0.$$

Therefore, $A_3 = 28_{-0.05}^{0}$ mm.

6. Solution: for fig-4b, the location error of each dimension is:

for the dimension $15_{0}^{+0.25}$ mm of the hole O_2:

$$\Delta_{dw} = \frac{T_d}{2\sin\frac{\alpha}{2}} + \frac{T_d}{2} = \frac{0.1\text{mm}}{2\sin45^\circ} + \frac{0.1\text{mm}}{2} = 0.121\text{mm} < \frac{1}{2} \times 0.25\text{mm}$$

for the dimension $15_{0}^{+0.1}$ mm of the hole O_1:

$$\Delta_{dw} = \frac{T_d}{2\sin\frac{\alpha}{2}} - \frac{T_d}{2} = \frac{0.1\text{mm}}{2\sin45^\circ} - \frac{0.1\text{mm}}{2} = 0.021\text{mm} < \frac{1}{2} \times 0.1\text{mm}$$

It can be seen that this location scheme can meet the machining accuracy, and it is feasible.

For Fig-4d, the location error of each dimension is:

for the dimension $15_{0}^{+0.25}$ mm of the hole O_2:

$$\Delta_{dw} = \frac{T_d}{2\sin\frac{\alpha}{2}} - \frac{T_d}{2} = \frac{0.1\text{mm}}{2\sin45^\circ} - \frac{0.1\text{mm}}{2} = 0.021\text{mm} < \frac{1}{2} \times 0.25\text{mm}$$

for the dimension $15_{0}^{+0.1}$ mm of the hole O_1:

$$\Delta_{dw} = \frac{T_d}{2\sin\frac{\alpha}{2}} + \frac{T_d}{2} = \frac{0.1\text{mm}}{2\sin45^\circ} + \frac{0.1\text{mm}}{2} = 0.121\text{mm} > \frac{1}{2} \times 0.1\text{mm}$$

We know that this location scheme can't meet the machining accuracy, and it is irrational.

For Fig-4d, the location error of each dimension is:

for the dimension $15_{0}^{+0.25}$ mm of the hole O_2: $\Delta_{dw} = \frac{T_d}{2} = \frac{0.1\text{mm}}{2} = 0.05\text{mm} < \frac{1}{2} \times 0.25\text{mm}$

for the dimension $15_{0}^{+0.1}$ mm of the hole O_1: $\Delta_{dw} = \frac{T_d}{2} = \frac{0.1\text{mm}}{2} = 0.05\text{mm} = \frac{1}{2} \times 0.1\text{mm}$

We know that this location scheme can meet the machining accuracy reluctantly, and it is basically feasible.

五、判断题（True or false）

1. √　2. ×　3. √　4. ×　5. ×　6. √　7. √　8. √　9. ×　10. √

Ⅲ. Test papers 样卷

样卷Ⅰ（英文）

一、单项选择题（Making choice）

1. A hole is machined by drilling and reaming on a drilling machine. The process should be di-

vided into ____ .

A. two operations B. two working steps

C. two working positions D. one compound working step

2. The number of primary motion may be ____ .

A. only one B. two C. three D. four

3. The carbides used to cut both steels and cast irons belong to ____ .

A. YT type (P) B. YG type (K) C. YW type (M) D. diamond

4. The element which has the largest effect on cutting temperature is ____ .

A. cutting thickness B. cutting depth

C. feed D. cutting speed

5. In finish grinding, the grade and structure of grinding wheel should be ____ .

A. soft and dense B. soft and open

C. hard and dense D. hard and open

6. The gear cutting method which belongs to forming method is ____ .

A. gear milling B. gear shaping

C. gear shaving D. gear honing

7. There are ____ transmission chains in the lathe CA6140.

A. 2 B. 3 C. 4 D. 5

8. In mass production, the assembly method named as ____ is often used for the assemblies with less components (2) and higher accuracy.

A. interchangeable assembly method B. grouping assembly method

C. adjusting assembly method D. probability method

9. The error caused by forced deformation belongs to ____ .

A. machining principle error B. constant systematic error

C. variable systematic error D. random error

10. Generally, the last operation in a workpiece machining process is ____ .

A. finish grinding B. nitriding C. cleaning D. inspection

二、填空题 (Filling in the blanks)

1. There are four types of surface forming methods, i. e. tracing, ____, tangent tracing, ____ .

2. The functions of friction clutch of lathes are ____ and ____ .

3. The functions of cutting fluids are ____, lubricating, ____, anti-rusting.

4. The rules to arrange machining sequence should be followed as: rough machining first, then finish machining; ________; important surface machining first, then less important surface machining; ________ .

5. Process datum is divided into operation datum, ____, ____ and assembly datum.

三、判断题（True or false）

1. Of the three cutting variables, the cutting depth has the largest influence on the tool life. (　　)

2. The cutters made of high speed steel can be used to cut steel at higher speed than that of carbide cutters. (　　)

3. "−" γ_o should be selected in finish turning. (　　)

4. The hardness of abrasive does not represent the hardness of grinding wheel. (　　)

5. The basic element of process is operation. (　　)

6. The larger the grain number, the finer the grain size. (　　)

7. Selection assembly methods are only suitable for job production and small volume production. (　　)

8. All lathes are provided with lead screw. (　　)

9. The larger the tool life, the higher the cutting speed the cutter permits. (　　)

10. Workpiece positioning error belongs to systematic error. (　　)

四、名词解释（Term explanation）

1. CB6132A
2. build-up edge
3. machining accuracy
4. location datum

五、问答题（Short-answer questions）

1. Answer: make 2D drawing of a lathe cutter on P_o and P_r plane, and point out the γ_o, α_o, κ_r, κ_r' (the tool feed direction should be indicated).

2. what properties should the cutting tool materials have?

3. why should the $\overline{X}$-R chart be used unitedly to control the machining accuracy?

4. Answer: a batch of shafts are machined between centers on a lathe. After turning, it is found by inspecting the shaft that there is a kind of form error as shown in Fig-1. Try to analyze and indicate the possible reasons for producing this error.

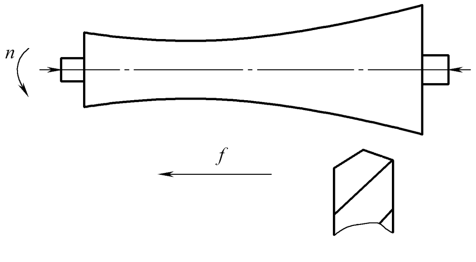


Fig-1

六、计算题（Calculation）

1. Solution：a sleeve-type workpiece is shown as Fig-2a. Its axial dimensions and machining operation drawings are illustrated in Fig-2. Try to find the operation dimensions L_1，L_2 and its deviations.

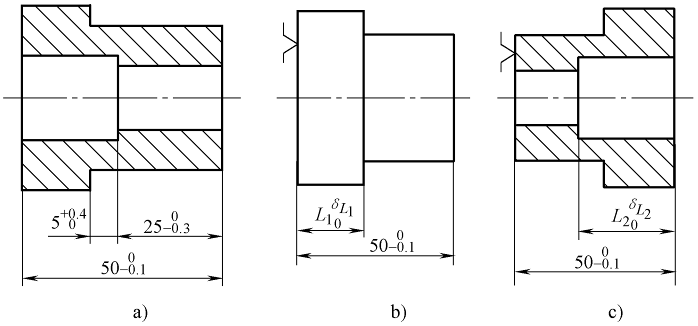


Fig-2

2. Solution：Fig-3 illustrates a speed-change gearbox assembly. The axial clearance A_0 should be ensured after the gear-shaft is assembled into the gearbox. Try to find out which dimensions would affect A_0，and establish the assembly dimensional chain. Suppose interchangeable assembly method is used，list briefly the procedure to find each dimension and its tolerance.

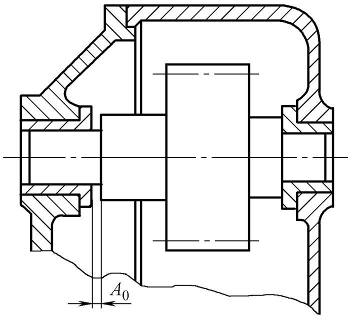


Fig-3

样卷Ⅱ（英文）

一、单项选择题（Making choice）

1. A shaft is machined respectively on a lathe and a grinding machine. The process should be

divided into ____ .

A. two operations B. two working steps

C. two worlciug positions D. one compound working step

2. For a machine tool labeled with MG1432, the correct expression is ____ .

A. a milling machine B. a grinding machine

C. a precise machine tool D. a sawing machine

3. The carbides used to cut cast irons only are ____ .

A. YT type B. YG type C. YW type D. diamond

4. The element which has the largest effect on cutting temperature is ____ .

A. cutting thickness B. cuttiag depth C. feed D. cutting speed

5. In finish grinding, the grain and structure of grinding wheel should be ____ .

A. coarse and dense B. coarse and open

C. fine and dense D. fine and open

6. The gear cutter used in generating method is ____ .

A. disc type gear milling cutter B. finger type gear milling cutter

C. gear broaching cutter D. hob

7. In the transmission system of the lathe CA6140, the spindle belongs to ____ .

A. executive member B. driving member

C. power source D. transmission device

8. In mass production, ____ . is selected prior to other assembly methods.

A. interchangeable assembly method B. grouping assembly method

C. adjusting assembly method D. probability method

9. The error caused by approximate forming motion belongs to ____ .

A. tool manufacturing error B. machine tool error

C. machining principle error D. random error

10. Generally, the heat treatment between semi-finishing and finishing phase is ____ .

A. normalizing B. annealing

C. quenching and tempering D. carburizing

二、填空题 (Filling in the blanks)

1. Four types of chips are ____, cracked chips, unit chips and ____ .

2. The technological system consists of machine tool, fixture, ____ . and ____ .

3. Three phases of assembling work are subgroup assembling, ____ and ____ .

4. Four kinds of standard threads can be cut on the lathe CA6140. They are ____, ____, module thread and pitch thread.

5. According to the function of datum, datum can be divided into ____, ____ .

三、判断题 (True or false)

1. Of the three cutting variables, the cutting depth has the largest influence on the tool life.

(　　)

2. Soft grinding wheels are generally used for machining hard materials. (　　)

3. The cutter with larger κ_r' should be selected in finish turning. (　　)

4. Operation is the basic element of process procedure. (　　)

5. The smaller the surface roughness, the higher the wear resistance. (　　)

6. The smaller the grain number, the finer the grain size. (　　)

7. Adjusting assembly methods are only suitable for large volume production. (　　)

8. All lathes can be used to cut lead screw. (　　)

9. Generally, longer tool life means that a cutter can be used at higher cutting speed. (　　)

10. Workpiece installation error belongs to systematic error. (　　)

四、名词解释（Term explanation）

1. rake angle
2. production program
3. error sensitive direction
4. closing link

五、问答题（Short-answer questions）

1. What factors should be considered when determining tool life?

2. According to the transmission system shown in Fig-1:

(1) To write out the expression formula of the transmission route of primary motion.

(2) To calculate the highest and lowest RPMs of the spindle Ⅵ in counter-clockwise when M_2 is disengaged.

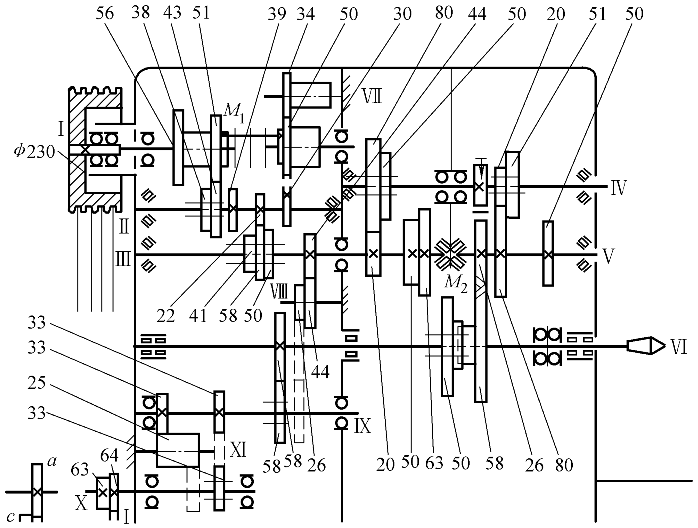


Fig-1 (RPM of motor is 1450r/min, pully diameter is ϕ130mm)

3. A batch of shafts are machined between centers on a lathe as shown in Fig-2. After turning, it is found by inspection that some shafts presented in taper. Try to analyze and indicate the possible reasons for the form error.

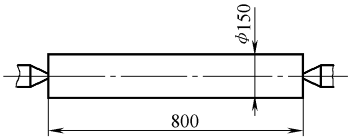


Fig-2

六、计算题（Calculation）

1. A sleeve with step hole is shown in Fig-3. After the bigger hole is machined, the length $10_{-0.36}^{0}$ mm must be ensured (Given that $50_{-0.17}^{0}$ mm has been got in former operation). Since $10_{-0.36}^{0}$ mm can not be measured directly, the depth of bigger hole should be indicated on the operation chart.

(1) Find the depth of bigger hole.

(2) If it is found by inspection that the depth of bigger hole is 40.25mm, is it reject or not? Why?

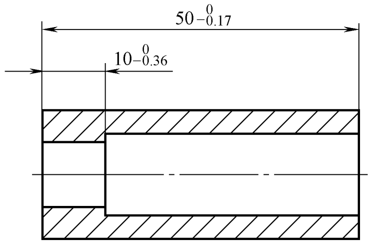


Fig-3

2. Fig-4 shows the assembling relation of a shaft and a gear. In order to insert the spring washer into between gear and shaft shoulder easily, the axial clearance $A_0 = 0_{+0.05}^{+0.42}$ mm should be ensured. Suppose interchangeable assembly method is used, try to find the limit deviation of each component link (Set $A_1 = 32.5$mm, $A_2 = 35$mm, $A_3 = 2.5$mm).

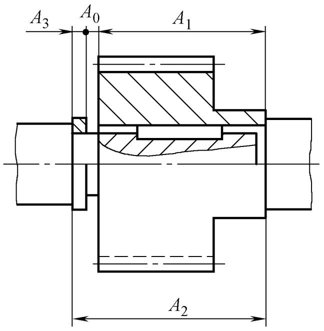


Fig-4

样卷Ⅲ（中文）

一、单项选择题

1. 由一个工人在一台设备上对一个工件所连续完成的那部分工艺过程，称为____。
A. 工位　B. 工序　C. 工步　D. 走刀
2. 在下述角度中，位于正交平面内的角度是____。
A. 主偏角　B. 副偏角　C. 前角　D. 刃倾角
3. 主要用于加工铸铁的刀具材料是____。
A. YT 类　B. YG 类　C. YW 类　D. 金刚石
4. 在下列要素中，对刀具寿命影响最大的是____。
A. 切削速度　B. 进给量　C. 背吃刀量　D. 切削层厚度
5. 多联齿轮小齿圈齿形加工方法一般选用____。
A. 滚齿　B. 插齿　C. 铣齿　D. 剃齿
6. 在车床上加工外圆，使用两顶尖组合定位，相当于____支承点。
A. 3 个　B. 4 个　C. 5 个　D. 6 个
7. 主要适合于小批生产时用钻头钻孔的钻套是____。
A. 固定钻套　B. 可换钻套　C. 快换钻套　D. 特殊钻套
8. 单件小批生产中，对于组成环数多而装配精度要求高的产品，常采用____。
A. 互换法　B. 选配法　C. 修配法　D. 调整法
9. 当精加工表面要求加工余量小而均匀时，选择定位精基准的原则是____。
A. 基准重合　B. 基准统一　C. 互为基准　D. 自为基准
10. 由刀具磨损引起的加工误差属于____。
A. 系统静误差　B. 常值系统误差　C. 变值系统误差　D. 随机误差

二、判断题

1. 在机床上加工零件时，主运动的数目可能不止一个。(　　)
2. 工艺系统由刀具、夹具、量具和辅具四部分构成。(　　)
3. 精加工时可选用较大的前角，以减小切削力。(　　)
4. YT 类硬质合金中 TiC 的质量分数越高，其硬度和耐磨性越高。(　　)
5. 精密磨削时应选用粒度号小的砂轮。(　　)
6. 少于六个定位支承点的定位方式就是欠定位。(　　)
7. 零件表面粗糙度值越小，表面磨损越小。(　　)
8. 在镗床上镗孔时，如果主轴有角度摆动，则镗出的孔呈椭圆形。(　　)
9. 机床的内联传动链中不允许采用链传动。(　　)
10. 普通车床导轨在垂直面内的直线度误差对加工精度影响较大。(　　)

三、填空题

1. 表面的成形方法有____、成形法、____和展成法。

2. 在 CA6140 型车床上可加工米制螺纹、____、径节螺纹、____四种螺纹。
3. 一个浮动支承可以限制____自由度，一个长 V 形块可限制____自由度。
4. 机床按通用程度划分，可分为____、____和专用机床。
5. 工艺基准可分为工序基准、____、____和装配基准。

四、名词解释（每小题 3 分，共 15 分）

1. 辅助基准 2. C6140A 3. 不完全定位 4. 加工误差 5. 积屑瘤

五、问答题

1. 什么是磨床？万能外圆磨床与普通外圆磨床的主要区别是什么？在万能外圆磨床上可以加工哪些类型的表面？

2. 钻床夹具由哪几部分组成？指出各部分的主要作用。

3. 图 1 所示为滚切直齿圆柱齿轮的工作原理图。利用图中标出的序号和符号，分别写出主运动传动链、展成运动传动链和轴向进给传动链，并说明哪个运动是简单运动，哪个运动是复合运动。

4. 在车床的两顶尖间车削一圆柱形工件（图 2）时，经检查发现有锥度误差（左端直径大于右端直径）。试分析其产生的原因。

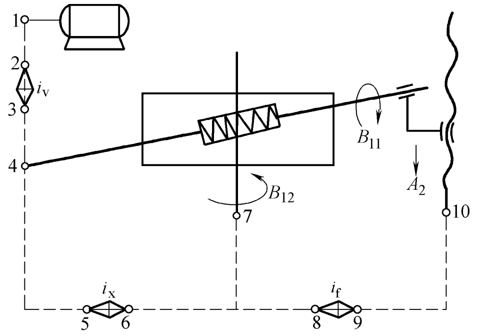


图 1

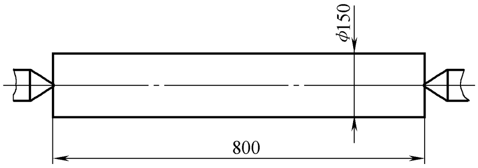


图 2

5. 图 3 所示连杆以平面和两个短 V 形块 1、2 定位，各定位元件限制了哪些自由度？有无过定位现象？如有，如何改进？

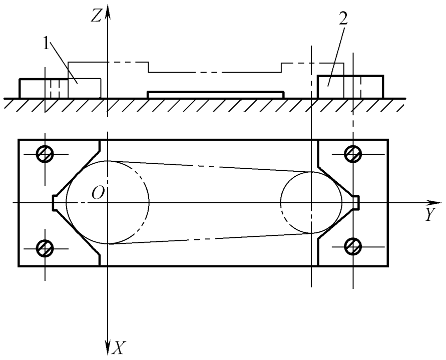


图 3

六、计算题

1. 图 4 所示为套筒零件，加工表面 A 时要求保证尺寸 $10^{+0.2}_{0}$mm，在铣床上采用调整法加工时以左端端面定位，试标注此工序的工序尺寸。

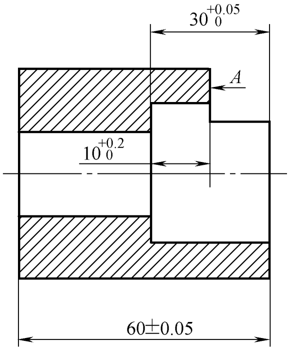


图 4

2. 工件定位如图 5 所示，欲钻孔 O 并且保证尺寸 A，试分析计算此种定位方案的定位误差。已知大圆直径为 $d_{1}{}_{-T_{d_1}}^{0}$，小圆直径为 $d_{2}{}_{-T_{d_2}}^{0}$，两圆的同轴度误差为 $2e$，V 形块夹角为 α。

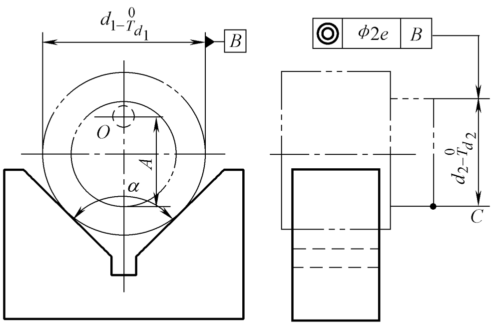


图 5

样卷Ⅳ（中文）

一、单项选择题

1. 在加工表面、切削刀具以及切削速度和进给量都不变的情况下所连续完成的那部分工艺过程，称为____。

A. 工位　　B. 工序　　C. 工步　　D. 走刀

2. 在基面内测量的角度是____。

A. 主偏角　　B. 刃倾角　　C. 前角　　D. 后角

3. 主要用于精加工碳钢及合金钢的刀具材料是____。

A. YT5　B. YG6　C. YT30　D. YG8

4. 在下列要素中，对表面粗糙度影响最大的是____。

A. 切削速度　B. 进给量　C. 切削深度　D. 切削层厚度

5. 大批量生产中精加工连杆小头孔常用的方法是____。

A. 钻—扩　B. 钻—扩—铰　C. 钻—精镗　D. 钻—拉削

6. 硬齿面齿轮的精加工方法一般选用____。

A. 铣齿　B. 插齿　C. 剃齿　D. 磨齿

7. 在车床上车削长轴时使用反三爪和右顶尖组合定位，相当于____支承点。

A. 6 个　B. 5 个　C. 4 个　D. 3 个

8. 适合于大批生产时用钻头钻孔的钻套是____。

A. 固定钻套　B. 可换钻套　C. 快换钻套　D. 特殊钻套

9. 通过控制零件加工误差来保证产品装配精度的方法是____。

A. 互换法　B. 选配法　C. 修配法　D. 调整法

10. 刀具制造误差属于____。

A. 常值系统误差　B. 变值系统误差

C. 随机误差　D. 系统动误差

二、判断题

1. 在机床上加工零件时，主运动的数目只有一个。(　　)
2. 工艺装备一般是指刀具、夹具、量具和辅具等。(　　)
3. 车削细长轴时应选用较大的主偏角，以减小背吃刀抗力。(　　)
4. YG 类硬质合金中钴的含量越高，其硬度和耐磨性越高。(　　)
5. 粗砂轮的粒度号大。(　　)
6. 少于六个定位支承点的定位方式就是不完全定位。(　　)
7. 零件表面冷作硬化程度越高，其耐磨性越好。(　　)
8. 在镗床上镗孔时，如果主轴有径向圆跳动，则镗出的孔呈椭圆形。(　　)
9. 一个三点浮动支承只约束一个自由度。(　　)
10. 普通车床导轨在水平面内的直线度误差对加工精度影响不大。(　　)

三、填空题

1. 获得尺寸精度的方法有____、调整法、____和自动控制法。
2. Y3150E 型滚齿机可加工直齿轮、____和____。
3. 机械加工中的振动类型主要有____和____两种。
4. 基本的夹紧机构类型有____、____和偏心夹紧机构。
5. 工艺基准可分为定位基准、____、测量基准和____。

四、名词解释

1. 工艺规程，2. 原理误差，3. 工艺系统，4. 装配，5. 复合成形运动

五、问答题

1. 什么是铣床？万能卧式升降台铣床与普通卧式升降台铣床的主要区别是什么？简述铣削加工的特点。

2. 刀具前角有何作用？应如何选择？

3. 图 1 所示为卧式车床的传动原理图。利用图中标出的序号和符号，分别写出主运动传动链和轴向进给传动链，并说明哪个传动链是外联传动链，哪个传动链是内联传动链，哪个运动是简单运动，哪个运动是复合运动。

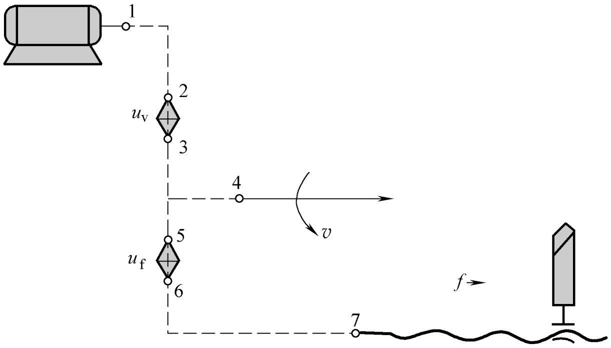


图 1

4. 在车床的两顶尖间车削一圆柱形工件（图 2）时，经检查发现有鼓形误差。试分析其产生的原因。

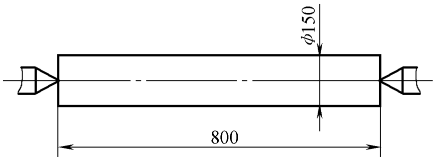


图 2

5. 图 3 所示连杆以平面 3、短 V 形块 1 和支承钉 2 定位同时钻两孔，并在连杆的中部进行夹紧。各定位元件限制了哪些自由度？图中的定位、夹紧是否合理？为什么？

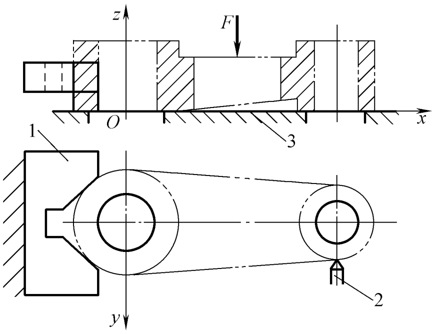


图 3

六、计算题

1. 如图 4 所示，为保证切槽深度的设计尺寸 $5^{+0.2}_{0}$mm，切槽时以端面 1 为测量基准，控制孔深 A。试求工序尺寸 A 及其上、下极限偏差。

2. 在圆柱工件上铣缺口的定位如图 5 所示，要求保证尺寸 $4^{0}_{-0.15}$mm 和 $8^{0}_{-0.2}$mm。试分别计算此种定位方案对尺寸 $4^{0}_{-0.15}$mm 和 $8^{0}_{-0.2}$mm 的定位误差。已知圆柱直径为 $\phi80^{0}_{-0.1}$mm，V 形块夹角为 90°。

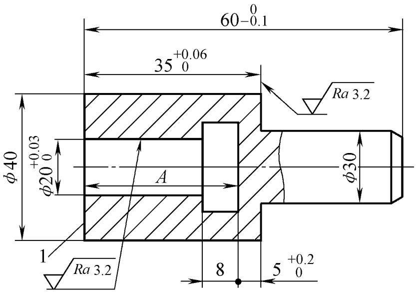


图 4

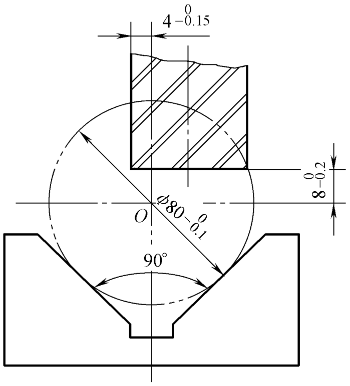


图 5

Ⅳ. Answers to test papers 样卷答案

样卷Ⅰ（英文）

一、单项选择题（Making choice）

1. B　2. A　3. C　4. D　5. C　6. A　7. B　8. B　9. B　10. D

二、填空题（Filling in the blank）

1. forming，generating
2. transmitting power，overloading prevention
3. cooling，washing
4. to machine datum surface first，then other surfaces；to machine flat surface first，then hole making
5. location datum，measurement datum

三、判断题（True or false）

1. ×　2. ×　3. ×　4. √　5. √　6. √　7. ×　8. ×　9. ×　10. ×

四、名词解释（Term explanation）

1. CB 6132A：C—lathe；B—semi-automatic；6—group code，horizontal spindle；
1—series code，general；32—Swing over the bed is 320mm；
A—significant improvement for the first time.

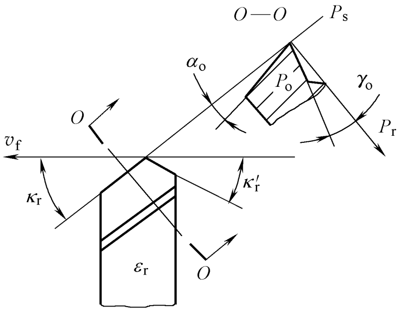
2. Build-up edge：A piece of metal adhered firmly to the tool face which can cut the workpiece instead of the cutting edge.

3. Machining accuracy：It means the talling level of the geometric parameters of workpiece after being machined with that of ideal workpiece.

4. Location datum：The datum which is used to locate the workpiece is called location datum.

五、问答题（Short-answer questions）

1. the projection of lathe cutter on reference plane and orthogonal plane are shown in Answer Fig-1.



Answer Fig-1

2. Answer：①Sufficient strength. ②Sufficient toughness. ③Wear resistance. ④Red（Hot）Hardness. ⑤Other properties：high thermal conductivity，low coefficient of thermal expansion，not be distorted after heat treatment，easy to manufacture.

3. Answer：generally speaking，both systematical errors and random errors are exist in workpiece machining process. As we know，$\overline{X}$ diagram reflects the variable trend of systematical errors，and R diagram reflects the variable trend of random errors. In order to ensure machining accuracy，both systematical errors and random errors should be controlled. Therefore，$\overline{X}$-R diagram should be used.

4. Answer：1）Guide way protrudes to the back side（guide way′s straightness error in horizontal plane.

2）Rigidity of tailstock is lower than that of headstock.

3）Parallism error of guide ways（twist）.

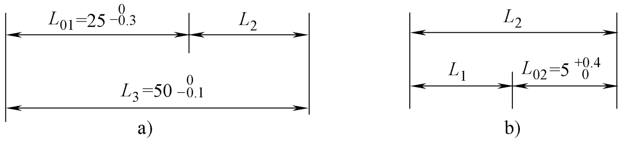
4）Blank error coping.

5）Tailstock offsetting to back side.

六、计算题（Calculation）

1. Solution:

Step 1: To establish dimensional chain, as shown in Answer Fig-2.



Answer Fig-2

In dimensional chain Answer Fig-2a, closing link: $L_{01}=25^{\ 0}_{-0.3}$mm, increasing link: L_3, decreasing link: L_2.

in demension chain Answer Fig-2b, closing link: $L_{02}=5^{+0.4}_{\ 0}$ mm, increasing link: L_2, decreasing link: L_1.

Step 2: To find L_1 and L_2 and its tolerance.

According to Answer Fig-2a, $L_2=25$mm, $ES_{L_2}=+0.2$mm, $EI_{L_2}=0$mm.

Therefore $$L_2=25^{+0.2}_{\ 0}\text{mm}.$$

According to Answer Fig-2b, $L_1=20$mm, $ES_{L_1}=0$mm, $EI_{L_1}=-0.2$mm.

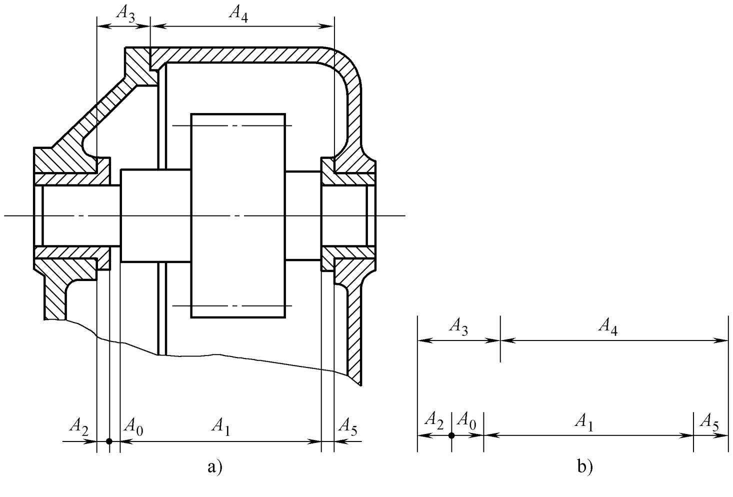
Therefore $$L_1=20^{\ 0}_{-0.2}\text{ mm}.$$

2. Solution:

Step1: To establish the assembly dimensional chain shown in Answer Fig-3b and verify the basic dimension of each link .

1) Closing link: A_0, increasing link: A_3, A_4, decreasing link: A_1, A_2, A_5.

2) $A_0=A_3+A_4-A_1-A_2-A_5$.



Answer Fig-3

Step2: To determine the tolerance of each component link: $T_{A_i}=\frac{T_{A_0}}{n-1}$, then adjust the tolerance of each component according to each component size and machining conditions.

Step3: To determine the limit deviation of component links.

A_2 is determined to be the coordination link, so the limit deviation of other component links can be determined firstly based on the Basic shaft System or Basic hole System, and $A_{2EI_{A_2}}^{ES_{A_2}}$ should be calculated lastly.

Step4: To calculate the ES_{A_2} and EI_{A_2} by means of the formula for calculating dimensional chain.

样卷Ⅱ（英文）

一、单项选择题（Making choice）

1. A　2. B　3. B　4. D　5. C　6. D　7. A　8. A　9. C　10. D

二、填空题（Filling in the blanks）

1. ribbon chips, splintering chips
2. cutting tool, workpiece
3. assembly/unit assembling, general assembling
4. metric system thread, british/inch system thread
5. design datum, process datum

三、判断题（True or false）

1. ×　2. √　3. ×　4. √　5. ×　6. ×　7. ×　8. ×　9. ×　10. ×

四、名词解释（Term explanation）

1. Rake angle: The angle included between the trace of rake face and the reference plane.
2. Production program: The yield of a product per year (including spares and rejects).
3. Error sensitive direction: The normal direction of being machined surface.
4. Endlink: It is obtained indirectly or formed finally in manufacturing according to the machining or assembling sequence.

五、问答题（Short-answer questions）

1. Answer: It depends on what kind of tool life T is adopted, that is, tool life T_p of the max. productive rate or tool life T_c of the mini. production cost. In practical production, T is usually determined according to T_c. But, under abnormal conditions, T can also be determined based on T_p. Besides, other factors should be considered, such as the complexity of cutting tool, difficulty in tool manufacturing, and what kind of situation is the cutting tool used and so on. For example, the

cutting tools with complex structure, or difficulty in resharpening and adjusting, or used on multi-spindle machine tools should have longer tool life.

2. Answer: (1)

$$\text{Motor}-\frac{\phi 130}{\phi 230}-\text{I}-\left\{\begin{array}{l} M_1\ (\text{left})-\left\{\begin{array}{l}56/38\\51/43\end{array}\right\}-\!- \\ M_1\ (\text{right})-50/34-\text{VII}-34/30 \end{array}\right\}-\text{II}\left\{\begin{array}{l}39/41\\30/50\\22/58\end{array}\right\}-$$

$$\text{III}-\left\{\begin{array}{l} \left\{\begin{array}{l}20/80\\51/50\end{array}\right\}-\text{IV}-\left\{\begin{array}{l}20/80\\51/50\end{array}\right\}-\text{V}-26/59-M_2 \\ -\!-\!-\!-63/50-\!-\!-\!-\!-\!-\!-\!- \end{array}\right\}-\!-\text{VI}\ (\text{Spindle})$$

(2) When M2 is disengaged, $n_{max}=1400\text{r/min}$; $n_{min}=450\text{r/min}$.

3. Answer: guide way is not parallel to the connection line of two centers in horizontal plane. ②Rigidity of tailstock is not equal to that of headstock. ③Parallelism error of guide ways (twist). ④Blank error coping. ⑤Tailstock offsetting. ⑥Tool wear (if $d_{左}>d_{右}$).

六、计算题 (Calculation)

1. Solution:

(1) Step 1: To establish dimensional chain: In dimensional chain Answer Fig-1, closeal link $A_{\Sigma}=10_{-0.36}^{\ 0}$mm, increasing link: $A_1=50_{-0.1}^{\ 0}$mm, decreasing link A_2.

Step 2: To find A_2 and its tolerance.

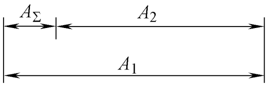
$A_{\Sigma}=A_1-A_2 \rightarrow A_2=40$

$ES_{A_{\Sigma}}=ES_{A_1}-EI_{A_2} \rightarrow EI_{A_2}=0$mm

$EI_{A_{\Sigma}}=EI_{A_1}-ES_{A_2}ES_{A_2}=+0.19$mm

$A_2=40_{\ 0}^{+0.19}$mm.

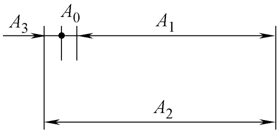
(2) If $A_2'=$ 40.25mm, when $A_1=49.89\sim50$mm, it is qualified; otherwise, it is reject.



Answer Fig-1

2. Solution:

Step1: To establish the assembly dimensional chain (Answer Fig-2) and verify the basic dimension of each link.



Answer Fig-2

1) Closing link: $A_0=0_{+0.05}^{+0.42}$mm; increasing link: A_2; decreasing link: A_1, A_3.

2）$A_0 = A_2 - A_1 - A_3 = 35\text{mm} - 32.5\text{mm} - 2.5\text{mm} = 0\text{mm}$.

Step2：To determine the tolerance of each component link：$T_{A_i} = \dfrac{T_{A_0}}{n-1} =$（0.42mm−0.05mm）/ 3≈0.123mm.

Then adjust the tolerance of each component according to each component size and machining conditions.

A_3 is determined to be the coordination link，Take $T_{A_1} = 0.12\text{mm}$，$T_{A_2} = 0.20\text{mm}$，then $T_{A_3} = 0.05\text{mm}$.

Step3：To determine the limit deviation of component links.

The limit deviation of other component links can be determined firstly based on the Basic Shaft System or Basic Hole System，that is：$A_1 = 32.5_{-0.12}^{0}\text{mm}$，$A_2 = 350_{0}^{+0.2}\text{mm}$，then

$$EI_{A_0} = EI_{A_2} - ES_{A_1} - ES_{A_3} \rightarrow ES_{A_3} = -0.05\text{mm}$$

$$\text{Then } EI_{A_3} = -0.10\text{mm}$$

$$A_3 = 2.5_{-0.10}^{-0.05}\text{ mm}$$

样卷Ⅲ（中文）

一、单项选择题

1. B　2. C　3. B　4. A　5. B　6. C　7. A　8. C　9. D　10. C

二、判断题

1. ×　2. ×　3. √　4. √　5. ×　6. ×　7. ×　8. √　9. √　10. ×

三、填空题

1. 轨迹法、相切法　2. 英制螺纹、模数螺纹　3. 1个、4个
4. 通用机床、专门化机床　5. 定位基准、测量基准

四、名词解释

1. 辅助基准：为了加工需要而在零件上特意加工出来的定位面。
2. C6140A：床身上最大加工直径为400mm且经过第一次重大改进的普通车床。
3. 不完全定位：根据加工要求，并不需要限制工件全部自由度的定位方式。
4. 加工误差：工件加工后的实际几何参数与理想几何参数的偏离程度。
5. 积屑瘤：黏附在刀具前面上的金属块。

五、问答题

1. 答：用磨料磨具（砂轮、砂带、油石、研磨料等）作为工具对工件进行切削加工的机床称为磨床。主要区别是在万能外圆磨床上配备有内圆磨具。可在单件小批生产中加工内外圆柱面、圆锥面、轴肩端面等。

2. 答：钻床夹具由定位元件、夹紧装置、导向元件（钻套）、夹具体等组成。定位元件用于确定工件在夹具中的正确位置；夹紧装置使工件在切削时仍保持既定位置；导向元件（钻套）用于确定刀具位置并引导刀具进行加工；夹具体用于连接并固定夹具上各元件及装置，使其成为一个整体。

3. 答：

（1）主运动传动链为：电动机—1—2—i_v—3—4—滚刀，这是简单运动。

（2）展成运动传动链为：滚刀—4—5—i_x—6—7—工件，这是复合运动。

（3）轴向进给传动链为：工件—7—8—i_f—9—10—刀架，这是简单运动。

4. 答：可能的原因有：①头架刚度比尾座刚度小；②尾座向前偏置；③刀具磨损；④毛坯误差复映；⑤导轨扭曲。

5. 答：底平面共限制沿 Z 轴移动，绕 X 轴、Y 轴的转动；V 形块 1 限制沿 X 轴和 Y 轴的移动；V 形块 2 限制沿 Y 轴移动和绕 Z 轴的转动。

属于过定位。定位不合理。

改进措施：把固定 V 形块 2 改成能沿 Y 轴移动的浮动 V 形块。

六、计算题

1. 解：

1）建立尺寸链，如答案图 1 所示。其中，封闭环 $L_0=10^{+0.2}_{0}$mm，增环 L、$L_2=30^{+0.05}_{0}$mm，减环 $L_1=60\pm0.05$mm。

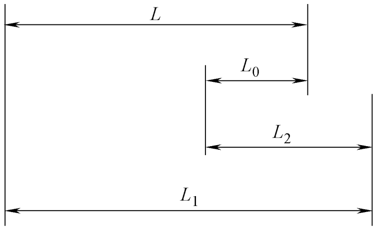
（2）解尺寸链：

$L_0=L+L_2-L_1$，$L=40$mm

$$ES_L=ES_{L_0}+EI_{L_1}-ES_{L_2}=+0.10\text{mm}$$

同理，$EI_L=+0.05$mm

所以，$L=40^{+0.10}_{+0.05}$mm



答案图 1

2. 解：对于工序尺寸 A，因为定为基准是工件大圆的中心线，而工序基准为小圆的下素线，故 $\Delta B=2e+T_{d_2}/2$；

对于 V 形块定位，$\Delta_Y=T_{d_1}/[2\sin(\alpha/2)]$。

由于在 Δ_B 和 Δ_Y 的计算式中没有相同因子，即两者没有关联，故对于尺寸 A 的定位误差为

$$\Delta_{dw}=\Delta_Y+\Delta_B=T_{d_1}/[2\sin(\alpha/2)]+2e+T_{d_2}/2$$

样卷Ⅳ（中文）

一、单项选择题

1. C　2. A　3. C　4. B　5. D　6. D　7. B　8. B　9. A　10. A

二、判断题

1. √　2. √　3. √　4. ×　5. ×　6. ×　7. ×　8. √　9. √　10. ×

三、填空题

1. 试切法、定尺寸刀具法　2. 斜齿轮、蜗轮　3. 受迫振动、自激振动
4. 斜楔夹紧机构、螺旋夹紧机构　5. 工序基准、装配基准

四、名词解释

1. 工艺规程：把零部件的制造工艺过程的所有内容用图、表、文字的形式规定下来的工艺文件。

2. 原理误差：由于采用了近似的加工方法、近似的成形运动或近似的刀具轮廓进行加工所产生的误差。

3. 工艺系统：由机床、夹具、刀具和工件构成的加工系统。

4. 装配：将若干个零件或部件进行必要的配合和连接，使之成为合格产品的过程。

5. 复合成形运动：由两个或两个以上的旋转或直线运动按照某种运动关系组合而成的独立成形运动。

五、问答题

1. 答：用铣刀对工件进行切削加工的机床称为铣床。主要区别是在工作台与床鞍之间增加了一层转台。转台可相对于床鞍在水平面内调整一定角度，使工作台的运动轨迹与主轴成一定的夹角，以便加工螺旋槽等表面。铣削是多刃切削，切削效率高，但铣削是断续切削，易引起机床振动。

2. 答：前角对切削的难易程度有很大影响。增大前角使切削刃锋利，使有助于减小切削力和切削热。但前角过大，会使切削刃强度下降，刀具散热体积减小，影响刀具寿命。工件材料的强度、硬度低，前角应选得大些，反之小些；刀具材料韧性好，前角可选得大些。精加工时，前角可选得大些；粗加工时应选得小些。

3. 答：

1）主运动传动链为：电动机—1—2—u_v—3—4—主轴，这是外联传动链，属于简单运动。

2）轴向进给传动链为：主轴—4—5—u_f—6—7—刀架，这是内联传动链，属于复合运动。

4. 答：可能的原因有：①工件刚度小于头架、尾座的刚度；②导轨在水平面内的直线度误差；③导轨扭曲；④毛坯误差复映。

5. 答：平面 3 共限制沿 Z 轴的移动，绕 X 轴、Y 轴的转动；V 形块 1 限制沿 X 轴和 Y 轴的移动；支承钉 2 限制绕 Z 轴的转动。

支承钉 2 定位不合理，难以保证钻孔时的壁厚均匀；夹紧力作用部位不合理，容易使连杆产生变形。

六、计算题

1. 解：

1）建立尺寸链，如答案图 1 所示。

其中，封闭环 $A_0=5^{+0.2}_{\ 0}$mm，增环 $A_1=35^{+0.06}_{\ 0}$mm，减环为 A。

2）解尺寸链：

$$A_0=A_1-A,\ A=30\text{mm}$$

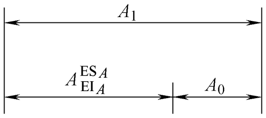
$$ES_A=EI_{A_1}-EI_{A_0}=0\text{mm}$$

同理

$$EI_A=-0.14\text{mm}$$

所以

$$A=30^{\ 0}_{-0.14}\text{mm}$$



答案图 1

2. 解：

1）对于工序尺寸 $4^{\ 0}_{-0.15}$，因为定位基准和工序基准均为圆柱工件的垂直中心线，故 $\Delta_{B4}=0$mm；因为 V 形块具有对中性，故 $\Delta_{Y4}=0$mm；所以 $\Delta_{dw4}=0$mm。

2）对于工序尺寸 $8^{\ 0}_{-0.2}$，因为定位基准和工序基准均为圆柱工件的水平中心线，故 $\Delta_{B8}=0$mm；对于 V 形块定位，$\Delta_{Y8}=Td/[2\sin(\alpha/2)]=0.1/(2\ \sin45°)=0.071$mm；所以 $\Delta_{dw8}=\Delta_{Y8}+\Delta_{B8}=0.071$mm。

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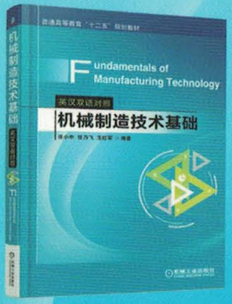

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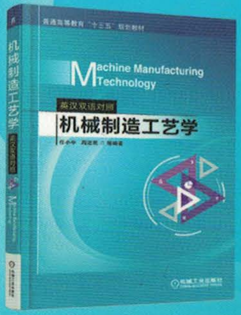

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